SECOND AMERICAN SURGICAL ASSOCIATION NUMBER

Vol. LXXXII SEPTEMBER, 1925 No. 3

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

Edited by

LEWIS STEPHEN PILCHER, M.D., LL.D.

of New York

With the Association of

JAMES TAFT PILCHER, B.A., M.D.

and the Collaboration of

W. SAMPSON HANDLEY, M.S., M.D., F.R.C.S.

of London

THE SURGICAL TREATMENT OF HABITUAL CRIMINALS, IMBECILES, PERVERTS, PAUPERS, MORONS, EPILEPTICS AND DEGENERATES 321
Albert J. Ochsner, M.D. ..... Chicago, Ill.
THE CONCEPTION OF SEPTICÆMIA 326
Walton Martin, M.D. ..... New York, N.Y.
FAT EMBOLISM 336
A. W. Elting, M.D. and C. E. Martin, M.D. ..... Albany, N.Y.
OPERATIVE TREATMENT OF ANGINA PECTORIS 354
Harry Hyland Kerr, M.D., C.M. ..... Washington, D.C.
ACUTE MASSIVE COLLAPSE OF THE LUNGS 366
Chevalier Jackson, M.D. and Walter Estell Lee, M.D. ..... Philadelphia, Pa.
EXTRACTION OF PROJECTILES IN THE LUNG 390
J. J. Buchanan, M.D. ..... Pittsburgh, Pa.
RADIUM IN BREAST CANCERS 404
B. J. Lee, M.D. and R. E. Herrendeen, M.D. ..... New York, N.Y.
SPLENECTOMY FOR PURPURA HEMORRHAGICA 413
Malvern B. Clopton, M.D. ..... St. Louis, Mo.
THE SEQUELÆ OF GASTRO-ENTEROSTOMY 421
Donald C. Balfour, M.D. ..... Rochester, Minn.
PRIMARY CARCINOMA OF THE SMALL INTESTINE 429
Alexander Primrose, C.B., M.B., C.M. ..... Toronto, Ontario
INTUSSUSCEPTION DUE TO MECKEL'S DIVERTICULUM 436
William E. Lower, M.D. ..... Cleveland, Ohio
REDUCIBLE OBLIQUE INGUINAL HERNIA 441
Ellsworth Eliot, Jr., M.D. ..... New York, N.Y.
BROKEN-DOWN ABDOMINAL INCISIONS 452
Arthur M. Shipley, M.D. ..... Baltimore, Md.
PARTIAL RESECTION OF THE KIDNEY 463
Edward Starr Judd, M.D. ..... Rochester, Minn.
METHODS OF URETERAL REPAIR AND TRANSPLANTATION 472
Charles H. Mayo, M.D. ..... Rochester, Minn.
IMPLANTATION OF AN OVARY 475
William L. Estes, M.D. ..... Bethlehem, Pa.
MANAGEMENT OF BILATERAL OVARIAN DERMOIDS 483
Frank S. Mathews, M.D. ..... New York, N.Y.
TREATMENT OF UTERINE FIBROIDS 486
J. B. Deaver, M.D. and S. P. Reimann, M.D. ..... Philadelphia, Pa.
TREATMENT OF UTERINE PROLAPSE AND RECTOCELE 501
John Homans, M.D. ..... Boston, Mass.
A HANGER METHOD FOR THE REPAIR OF PROCIDENTIA UTERI 509
George W. Crile, M.D. ..... Cleveland, Ohio
LATE RESULT OF NEEDLING AN AORTIC ANEURISM 514
John A. C. Macewen, M.D. ..... Glasgow, Scotland

J. B. LIPPINCOTT COMPANY, PUBLISHERS

MONTREAL PHILADELPHIA LONDON

To sustain the heart

Digitan

A Physiologically Standardized Preparation of the Digitaminoids

Ampuls, for injection, 1 Cc. each, boxes of 6
Oral Solution, (Special tincture) Vials of 12 Cc.
Tablets: 1¼ grains, tubes of 12
Powder: In vials of ⅕ oz.

Literature and Sample on request

Merck & Co. New York

"METZ MADE MEDICINALS"

"THE DEPENDABLE ORIGINALS"

manufactured in the United States in strict conformity with the processes and formulas of the originators

OFFER THE PHYSICIAN THE BEST

Neosalvarsan

There is no substitute for this product from the standpoint of clinical results or low toxicity, coupled with minimum cost to the medical profession.

Novocain

THE DOCTORS FIRST THOUGHT in LOCAL ANESTHESIA

whether used in powder, tablet or the ready-to-inject ampule form, gives the operator perfect local anesthesia.

Years of clinical employment throughout the entire world have stamped these dependable originals as agents of unequalled therapeutic effectiveness.

H. A. METZ LABORATORIES INC.

ANNALS of SURGERY

VOL. LXXXII SEPTEMBER, 1925 No. 3

THE SURGICAL TREATMENT OF HABITUAL CRIMINALS, IMBECILES, PERVERTS, PAUPERS, MORONS, EPILEPTICS AND DEGENERATES*

BY ALBERT J. OCHSNER, M.D.

OF CHICAGO, ILL.

MORE than twenty-three centuries ago Plato (424–344 B. C.) advocated castration as a punishment for certain crimes. Since that time the subject has been advocated many times, especially by authors interested in eugenics, insanity and criminology, but not by surgeons. In many communities mob justice has made use of this idea in the treatment of isolated cases. During late years fifteen states have passed laws for the sterilization of individuals belonging to those classes.

There has been strenuous objection raised to this form of punishment, especially by the clergy, because it seemed to them to be a direct interference with the will of an allwise Providence. There was also something repulsive in the idea, because it seemed to contain a feeling of hatred toward the criminal. It also seemed to mark the criminal as an outcast. In earlier years it involved considerable risk to the criminal's life, thus resulting in the possibility of unintentional capital punishment. Moreover the operation involved physical suffering and a repulsive deformity and an interference with the criminal's constitutional right of enjoyment of "Life, liberty and the pursuit of happiness," after having undergone the hardships resulting from the just punishment of his crime. It has also been objected to because it was considered a cruel and unusual form of punishment which is considered unconstitutional.

In former times a condition which has loomed up to a remarkable extent of late could not be brought to bear upon this question as it can at present. The portion of the human family belonging to the group under consideration was so poorly cared for by society that most of the members' lives were not unduly prolonged. There was a natural elimination of the individuals belonging to these groups. Until comparatively recent times the biblical quotation remained true which said, "The children of the wicked shall be cut off." The death-rate during early life of their offspring was so great that only a relatively small portion remained as a burden to society because but few of them attained adult life. This, however, has all been changed by our modern methods of caring for these groups. Society at the present time

*The Presidential Address delivered before the American Surgical Association, May 4, 1925.

provides such excellent protection and care for all of the members of the groups under consideration that the scriptural quotation, "The wages of sin is death," has lost its force to a very great extent, and it is for this reason that society will be forced to protect itself against their progeny.

Criminals and defectives are exceedingly prolific, as has been demonstrated many times statistically, which is shown by the study of the histories of families belonging to these groups. One of the most striking examples is that of a well-known worthless family which settled in the State of Indiana some generations ago, consisting of a feeble-minded husband and wife, who were shiftless and given to thieving. Their descendants now number nearly 1200, most of them, at best, a burden to society and many of them degenerates, or criminals.

Another equally striking case, which has been carefully studied and described by Dr. Henry H. Goddard, Director of the Juvenile Research Bureau of the State of Ohio and formerly Superintendent of the School for Feeble-minded at Vineland, New Jersey, is the one known as the Kallikak family, whose history has been published so often that it need not be repeated here except as to its results. The descendants from the same father and a feeble-minded girl number 480, among them 143 known feeble-minded, 36 illegitimates, 33 sexual immoral, 24 confirmed alcoholics, 3 epileptics, 3 criminals, 8 keepers of brothels and 83 children so feeble that they died in infancy. On the other hand, the descendants of the same father and a fine mother comprise 496 normal people, all having lived normal, honorable lives without being a burden upon the public and many having given important public service. The provisions which organized society has established for their preservation has resulted in an enormous increase in the number of members of the groups under consideration.

Government statistics for the year 1915 show that the direct expense to our government for the care of these classes in charities, hospitals and corrections amounted to the enormous sum of $89,189,000, which is more than all the money spent in the maintenance of all the universities of this country. For the year 1922 this sum had increased to $162,469,000, an increase of 80 per cent. in a period of seven years. Almost the same proportions exist for the State of Illinois. For the year 1915 the cost amounted to $5,458,504, and this had increased to $8,901,247 for the year 1922. These classes do an enormous amount of harm and destroy a great amount of property each year which cannot be calculated, but which represents an enormous loss to the honorable portion of society at large, aside from the cost to the public for their support.

The amounts represented above simply represent the actual money expended by society for protection against these classes and for their care in institutions. This has produced a tremendous, rapidly increasing burden upon the remaining portion of society, because the care and support of the appalling number of these individuals and their offspring in penal institutions, asylums, almshouses, homes for defectives and hospitals produces an enor-

mous expense which is increasing from year to year, and which brings no benefit to those bearing the expense except a certain amount of protection.

It has been shown by statistics collected in the State of Indiana that one hundred families have committed more than one-half of the crimes done to native-born citizens during the past generation. But this is not all, for the offspring of the respectable members of society are constantly exposed to the harmful influence of contact with these degenerate classes and their offspring. Moreover, the lives of the offspring of these unfortunate classes are full of trouble and sorrow from their beginning to their miserable end, and few if any members of these classes do not regret the fact that they were born. In the same way the children of these classes are practically never welcome to their parents. Hence, depriving the latter of the possibility of progeny would in no way result in a hardship to these individuals.

If then it is possible, by the surgical treatment of these cases, to reduce the number of their progeny, it seems reasonable to advocate this surgical method so that society can be protected against at least a part of the harm it now suffers without harming the individuals who receive this surgical treatment. It seems to be plainly our duty not only to advocate methods which will save life and relieve suffering of the individual patient that comes under our care, but quite as much to protect society against unnecessary hardship.

The form of treatment I wish to advocate consists in the ligation and section of the vasa deferencia.

This can be accomplished in less than two minutes by any surgeon. The steps of the operation are as follows: (1) disinfection of the skin area; (2) infiltration of the skin and the tissues about the vas deferens with 1 per cent. of novocain solution, or one of its equivalents; (3) an incision 2 cm. long; (4) the bringing forward of the vas; (5) double ligation 1 cm. apart with silk or catgut; (6) section of the vas above the point of ligation; (7) closure of the wound with one or two catgut sutures and dressing of the wound.

This operation causes absolutely no pain and no deformity, does not endanger the life of the patient and does not in any way interfere with his sexual life with the one exception that it prevents reproduction. We have demonstrated many times in cases of double vasectomy for tuberculosis of the vas that the sexual life of the patient is not changed in the slightest degree. Some of these cases have enjoyed normal sexual life for a period of more than twenty-five years since the operation. In case the operation should at some time be performed erroneously, the vas can be restored.

This form of treatment will then effectually protect the community against the progeny of the individuals treated, without carrying with it the slightest harm to that individual. It does not contain the element of punishment and can therefore be applied to the other non-criminal classes contained in the group under consideration in the same manner that it can be applied to the

habitual criminal. Not containing the element of punishment, existing laws for the punishment of criminals would not have to be modified in any way because of the introduction of this form of treatment of the criminal.

At this point a word might be said concerning the sterilization of females of these classes. Nature has provided for the sterilization of almost all female criminals because they are practically all sterile as a result of gonorrhœal or luetic infection.

The female belonging to the other classes in this group should all be sterilized by the use of deep X-ray therapy, or by the ligation of the Fallopian tubes.

The objection which has been offered, especially by the clergy, is on a par with that offered in times past against vaccination for the protection against small-pox and other measures which seemed to prevent the functioning of the wrath of God through visitation of disease upon the inhabitants of a sinful world. With the increase of intelligence this obstruction must disappear, because it belongs to a type quite proper some centuries in the past, but no longer proper in this enlightened age. It must dawn upon these objectors that if Providence had planned non-interference the anatomic possibility of this interference would have been less obvious. There can be no doubt but what society has the absolute moral right to protect itself against harm from this source the same as from the many other forms of injury provided for by existing laws.

Everyone who has handled domestic animals knows that vicious characteristics of these animals are transmitted from parent to offspring, and this knowledge is made use of constantly in the selection of sires in the breeding of domestic animals. That the same is true in the human family has been proven constantly as shown by the accompanying well authenticated examples and by an endless number of similar observations.

Aside from this in case of criminals the influence of environment has, of course, a distinctly harmful effect, because the offspring of criminals are always born into a criminal environment.

A noted criminal lawyer who has been active constantly in the criminal court of a great city for many years states that he has many times encountered the sons of criminals guilty of the identical crimes for which their fathers were prosecuted many years before.

Fifteen states in the Union have passed laws authorizing sterilization for certain conditions. Of these nine are still in force, five having been declared unconstitutional and one having been repealed.

In 1922, the law had been carried out in 3233 cases, of which 2558 had been operated in the State of California.

All of these operations were performed upon insane patients in State Hospitals for the Insane.

Dr. F. W. Hatch, General Superintendent of Hospitals for the Insane of California, states that in his enormous experience vasectomy in the insane is followed in many cases by marked improvement in the mental condition,

which may be due to the absorption of secretion from the severed vas deferens, although suggestion may also have had a favorable influence. Dr. H. C. Sharp, Physician to the Indiana Reformatory, who has applied vasectomy since 1899, states that he has had under his post-operative observation 236 of these cases. He has never seen any unfavorable symptoms in any case. There has been no atrophy, no cystic degeneration, no disturbed mental or nervous condition, while he has noted improvement in the condition of some patients.

There is no doubt but what efficient laws can be passed, whose constitutionality will be upheld by the courts.

CONCLUSION

1. This form of treatment will eliminate in coming generations many individuals who would otherwise be born with vicious hereditary tendencies.

2. It will relieve society of much harm from contact with members of these classes.

3. It will greatly reduce an enormous useless financial burden.

4. It will remove from normal society the harmful influence due to vicious environment.

5. It will not injure the individuals treated.

6. It will cause no pain, produce no deformity, incur no danger to life, and it will not interfere with the health and happiness of those treated.

7. It will prevent the wretched existence of a most unfortunate class, who otherwise would have to suffer because of hereditary defects.

8. It is important to bear in mind that the proposed treatment is not a form of punishment, but a reasonable protection to future generations.

THE CONCEPTION OF SEPTICÆMIA AND THE FATE OF MICROBES IN THE BLOOD STREAM*

By Walton Martin, M.D.
of New York, N.Y.

If living pathogenic microörganisms penetrate the blood stream, is the blood infected as the cellular tissue is infected in a spreading phlegmon? Since the matrix is fluid in which the blood cells and the bacteria are floating, is an opportunity offered for the introduction of a chemical which will destroy the microbes and prove harmless to the living cells? It has seemed to me timely to attempt to bring forward some of the evidence available which may help to answer these questions. Timely, because a number of truly astounding recoveries have been reported, based on the assumption of an affirmative answer to both questions.

It has been shown by repeated experiments that if an inert substance, like lampblack, is introduced into the blood, it disappears in a short time. It is not passed out of the body by the urine or by any of the various excretions or secretions. The minute particles of the injected substance settle out from the blood where the circulation is unusually slow in the peculiar capillary meshwork of the spleen, the liver and the bone marrow. There they come in contact with a special group of cells and are taken up by them. These cells belong to a group now spoken of as the reticulo-endothelial system and are distinguished not only by a pronounced capacity for phagocytosis but by their special reaction to certain vital stains. It is well recognized that phagocytosis is a property of many other body cells, but it is a peculiar and especial function of these cells.

In experiments recorded in a paper by Hobo,[1] the material used was fine India ink and the amount used from 2.5 to 3.0 c.c. The particles were the same size or smaller than staphylococci and the solution was injected into the ear veins of rabbits. The visible mucous membranes immediately became dark gray; at the end of ten minutes this color had disappeared. The animals were killed at periods varying from forty-five minutes to seventeen days after the injection. At autopsy the spleen, the bone marrow and the liver were found to be stained black. The other organs and tissues—the lungs, heart, brains, nervous tissue, gastro-intestinal tract and the kidneys were unstained. The microscopical examination showed, even in the early stages, particles of India ink in the star cells of Von Kupffer of the liver, the sinus endothelial cells and the pulp cells of the spleen and the endothelium of the capillaries of the bone marrow. In the capillary enlargement of the metaphyses of the long bones the particles were so thickly deposited that it was impossible to recognize the phagocytosis. In the lungs and kidneys, clumps of the pigment

*Read before the American Surgical Association, May 5, 1925.

were seen here and there. Scattered through the various organs were mononuclear and polymorphonuclear leucocytes filled with the black particles.

During the last forty years numerous experimenters have shown that microbes injected into the blood current are deposited and detained in exactly the same way in the liver, the spleen and the bone marrow. The completeness and rapidity with which they are removed and their predilection for certain organs and tissues vary with the different microbes.

The precise and interesting experiments made by Wyssokowitsch [2] over thirty-nine years ago brought out many of these points. He used fresh cultures of moulds, saprophytic, pathogenic and non-pathogenic bacteria and experimented on dogs, rabbits and guinea pigs. Relatively large quantities were injected into a vein; blood was then withdrawn at intervals of from ten minutes to twenty-four hours; cultures were taken and the colonies counted. Enormous quantities of spores of moulds (aspergillus and pencillum) and saprophytic bacteria disappeared with astounding rapidity. Within three hours, millions of bacilli (bacillus subtilis), injected intravenously, had completely disappeared. Bacteria, pathogenic for man but harmless for the animals experimented on, disappeared in the same way. Thirty minutes after the injection of millions of cocci (streptococcus pyogenes) into the circulation of a dog, only one colony was found on the blood culture; in one and a half hours the blood withdrawn was sterile. Even after injections, repeated each day for four days, of many millions of microörganisms (micrococcus tetragenus) into the blood of rabbits, only six colonies had grown from the blood culture at the end of twenty-four hours.

The disappearance of bacteria pathogenic for the animal, injected in small quantities, was equally rapid. In some instances it was complete; that is, the blood withdrawn from a rabbit, into the blood stream of which anthrax bacilli had been introduced, showed no organisms at the end of twenty-four hours. If larger doses were introduced there was first a diminution, then an increase, until the bacteria became countless. In a rabbit injected with a large dose of anthrax bacilli, at the end of five minutes only fifteen colonies were found in the withdrawn blood. At the end of two and a half hours there were no colonies; at the end of forty-six and a half hours, three colonies; at the end of seventy hours, fifty-six colonies; at the end of eighty-four hours, death followed with countless numbers of bacteria in the blood stream. The animal in which no organisms were found in the blood at the end of twenty-four hours was killed. Cultures from the blood showed no growth; however, forty-five colonies grew from a culture taken from the spleen and countless colonies from the liver. In animals that died after the injection of large doses of pathogenic organisms, autopsies regularly showed not only the liver, spleen and bone marrow, but all the tissues and organs swarming with bacteria. The blood itself, in the larger vessels, contained but a small part of the myriads of microbes found throughout the body.

It is well to bear in mind that conclusions drawn from such animal experi-

ments should only be applied with caution to human beings. In the first place, the infecting agent is almost never introduced in large quantities intravenously into a healthy person. There is almost always a local area from which at first relatively few bacteria enter the circulation and such slow introduction sets up most important changes in the behavior and response of the body cells to the exciting agent. Even when a local tuberculous focus, for example, ruptures into a vein and tubercle bacilli in millions are carried through the body by the venous current, important changes must already have been set up in the body reactions by the presence of the bacteria in the original centre of activity. The great differences in the natural resistance of the various animals to the various exciting agents and in the virulence of the microorganisms, are too well known to be more than mentioned. There are also curious minute anatomical differences which cause confusion, such as the distribution of the reticulo-endothelial cell groups in different animals.

One may summarize the results in a very general way as follows: Microorganisms settle out from the blood where the current is unusually slow; they are very minute and behave at first as minute lifeless particles behave. It is clear that such settling out insures an opportunity for chance contact and adhesion with special cells. This contact is accompanied by phagocytosis and the formation of various bactericidal substances. If pathogenic bacteria are lodged and chance to grow, various toxic substances are produced which in their turn are harmful to the body cells.

That bacteria enter the blood from time to time and give little or no evidence of their presence, is well recognized. There is a curious experiment which I think worth recording. It was in 1879, in the early days of the study of the pathogenesis of infections. Watson Cheyne [3] made cultures from various abscesses on cucumber infusion. He thought at the time that the bacilli were pathogenic and that the cocci were not. He injected into his own arm, on two occasions, one and five minims of a culture of micrococci. He estimated that each minim contained at least two million microbes. There was no appreciable local or general reaction.

The usual sequence of events when infection occurs is as follows: At first there is a centre of activity with multiplication of bacteria and the formation of toxins; from this local focus the toxins and bacteria enter the blood; these bacteria are very rapidly taken up and destroyed by the cells of the reticulo-endothelial system at the same time this system elaborates bactericidal substances. Microörganisms are only very occasionally to be detected in this stage in the blood and usually only when a considerable number enter the blood stream at once. Gradually, however, the toxins of the bacteria inhibit or destroy the phagocytic cells and the bactericidal substances in the blood become less marked. The bacteria remain longer alive in the blood and, during this stage, certain of them may gain foothold and begin to grow in various parts of the body, forming secondary centres of activity and from these more bacteria and toxins enter the circulation. Finally, the phagocytes no longer

act; bactericidal substances are no longer formed, the microörganisms multiply throughout the body, myriads are poured into the blood from the spleen, bone marrow and liver and from the various secondary foci. In the early stages, even after repeated predatory incursions of bacteria, the microbic raids may cease and recovery take place, and recovery may also follow if the bacteria are cut off from entering the circulation or if the focus be completely removed. Every phase of this contest between the organisms and the body cells is seen. Now one, now the other, seems to be victorious. All manner of transitional forms exist. There are periods in which the bacteria are being killed or taken prisoner as soon as they appear. There are periods in which they are completely victorious. In looking at the contest at any given moment, it may be impossible to determine the outcome. It may be impossible, when living organisms are found in the blood stream, to be sure whether they are multiplying there or whether they are pouring into the stream from various foci. It is for this reason that the term septicæmia is no longer defined in the textbooks as a condition in which the organisms are actually multiplying in the blood current. The conception of septicæmia today implies the presence of living pathogenic microörganisms in the circulating blood. In common usage, one speaks of typhoid septicæmia and pneumococcus septicæmia when bacteria are present in the blood in typhoid and in pneumonia. Bacteræmia and septicæmia have come to be synonymous terms. In the chapter on septicæmia in the last edition of *Choyce's Surgery* (1923), bacteræmia is written in parenthesis after septicæmia. The term is used whenever there is actual, direct evidence of microörganisms in the circulating blood. Malaria stands out as a disease in which the older conception is most apt. Here organisms are actually proliferating in the circulating blood. The contest between the merozoites, which are set free after the disintegration of the red cells, and the leucocytes, may be actually in the peripheral blood stream. But in the astivo-autumnal type of the disease the development of the larger ameboid forms takes place largely in the spleen and the bone marrow and as soon as the plasmodium has grown a certain size it is no longer found in the circulating blood. It is discovered, however, in blood obtained by puncture from the spleen. And in the fatal cases, at autopsy, enormous numbers of the parasites, in all stages of development, are found in the spleen, the liver and the bone marrow.

In septic conditions following grossly contaminated wounds, such as are seen after gunshot injuries, special studies have shown bacteria in the blood stream, not only in severe types, but in many of the milder forms.[4, 5]

The course of events in the septicæmia following infection of the uterus has been very carefully studied by a number of observers. The raw surface left on the uterine wall after the separation of the placenta, the imperfectly drained cavity, the presence of decomposing fragments of placental tissue and blood clot, the rich supply of lymphatics and blood-vessels, all offer an unusually favorable opportunity for the growth of both saprophytic and pathogenic bacteria and their dissemination. It has been customary to group these cases

under the terms sapræmia and septicæmia but painstaking blood studies have shown that the cases grouped under sapræmia are frequently accompanied by bacteræmia and that, here again, all transitional forms between mild and severe types of septicæmia (bacteræmia) exist. The case reports and studies of Lenhartz [6] in this connection are most interesting.

The sequence of events in many septicæmias is somewhat different. The initial focus of infection is inconspicuous or absent. Bacteria pass from the initial lesion or from the portal of entry through the blood stream without any perceptible reaction on the part of the body. There is no direct evidence by blood culture of their presence. But just as we are accustomed to assume the passage of streptococci through the lymphatics when we find a small infected area on the little finger preceding an obvious phlegmon in the region of the epitrochlear gland, so in these cases the sequence of events seems to make it difficult to think of other explanations. For example, a small furuncle, a pustule or a trifling infected wound regularly precedes the development of an osteomyelitis. Staphylococci must pass from these small lesions directly or indirectly into a vein and be carried to the right heart, then through the lung capillaries and finally settle out where the circulation is unusually slow, in the liver, spleen and bone marrow, where they are destroyed. In the young animal, however, in the large venous capillaries of the metaphyses of the long bones, masses of the lodged bacteria are not killed but start to grow and the lesions of osteomyelitis are produced. Hobo (*l.c.*) has observed a lessened power of phagocytosis or an absence of it at just this point, whereas there is an active phagocytosis in the endothelial lining of the capillaries of the shaft.

It is well recognized that masses of bacteria can be established in a focus and maintain themselves in areas where the natural resistance is weakened. From these secondary centres of bacterial activity toxins and bacteria pass into the circulation. When they pass in considerable numbers they may be recognized by blood culture and the sequence of events that we described above takes place. The only difference is that the active foci, the ones with which we are familiar, the ones that we associate with the disease, are actually secondary foci.

The phase when the bacteria are passing unnoticed from a primary focus to become lodged in a secondary focus corresponds to the period of incubation in many of the so-called infectious diseases. During this period, the body shows no reaction to the invading bacteria. There is no chill or temperature or sign of illness. These start with the invasion of the blood stream from the established secondary focus or foci.

The comparison, first made by Virchow, of the struggle between the body cells and their products with the microbes and their toxins, as a battle, may be extended. This phase of the contest is like trench warfare. The first bacterial raids are carried out as surprise attacks. Very quietly, before it is realized, without the exchange of a shot, a trench is taken. From this trench,

after a time, further raids are made, but now under a destructive fire. Time after time, the raiding bacteria are destroyed by the phagocytes and bactericidal substances manufactured by the aroused body cells. Animal experiments have shown that by varying the dosage of microörganisms, that is, the numbers introduced, almost all the lesions that we are accustomed to see in the pyogenic infections may be reproduced. But in man these variations seem to be brought about rather by the varying phases of resistance and sensitiveness offered by the fluids and cells of the body to the invading organisms during the period when the microbes pass from the initial lesion to various parts of the body. That these phases have a most important bearing on the interpretation of the results of treatment and on the questions connected with subsequent infection, reinfection and superinfection, is evident.

Bacterial contamination of the blood stream is well shown in the study of infections of the middle ear. The mastoid cells are in close proximity to the lateral sinus. It has long been recognized that an infective thrombophlebitis not infrequently follows infection here, either by direct involvement of the walls of the sinus or by extension to the sinus through one of the minute communicating veins and that such involvement is made evident clinically by chills and fever. Cultures taken during these periods very frequently show the presence of bacteria in the blood stream. The prompt ligation or removal of the infected vein stops the process and the patient recovers. Although large numbers of bacteria have been poured into the blood they disappear completely and the patient recovers if the bacterial showers stop spontaneously or are cut off. The blood is bactericidal; the body cells destroy the microörganisms.

In malignant endocarditis, again, the focus of infection is directly in the vascular system. Careful studies have shown that for long periods the blood possesses powerful bactericidal properties against the very organisms producing the lesion. That pathogenic microörganisms can maintain themselves in a nidus while the circulating blood has powerful destructive properties for the particular microbes in the nidus, has been proved in a great variety of infections.

Our conception of septicæmia, built up by clinical observations made when pathogenic bacteria are detected in the circulating blood, must take into account all these cases. Examination of the contaminated blood gives but a small indication of the complex phenomena taking place. The number of microbes discovered may be but a portion of the myriads in the body or may only indicate the passage of hundreds of thousands on their way to destruction. To speak of the blood as infected in the sense that a local area is infected is misleading. The failure to consider the phenomena connected with the appearance and disappearance of microörganisms leads to most erroneous conclusions.

Since Ehrlich introduced the intravenous injection of salvarsan with such success in the treatment of syphilis, a number of other chemical substances

have been suggested and used intravenously for microbic infections. Not only Ehrlich's brilliant discovery but the scientific conception that prompted his work; the painstaking studies of the various chemical compounds; the addition of atomic group to atomic group with a definite purpose, until the complex chemical compound salvarsan (dioxydiamedoarsenobenzol dihydrochloride) was discovered with the properties required; the extension of the well-known side-chain theory to chemotherapy; all stimulated work and encouraged the hope that similar chemical substances with specific activity might be found for other microörganisms. It is interesting to note that, in offering an explanation for the action of salvarsan, the active formation of antibodies called forth by the parasites killed just after the injection was considered and a warning given of the danger present in certain cases from the endo-toxins liberated from the enormous number of spirochæta killed. His warning also against the use of the toxic chemical in patients with serious organic lesions and his unwillingness to have the drug placed on the market until it had been tested on twenty or thirty thousand patients, are all worthy of attention and imitation.[7]

The well-known therapeutic action of quinine on the plasmodia of malaria led Morgenroth and others to work on chemical substitution products in the molecules of this substance and finally, to the discovery of optochin, which has fifty times the power of quinine and kills, *in vitro*, pneumococci in a dilution of one to a million. Another compound—acridine, with its derivatives, flavine and acriflavine (trypaflavin, proflavin of the Germans) has also been studied extensively. A preparation containing 0.5 per cent. of free hypochlorous acid, made by dissolving a definite amount of chlorinate of lime and boric acid in equal parts in water, was introduced under the name of eusol and has been used not only as a local antiseptic but intravenously in various septic conditions. Churchman,[8] who began his studies on bacterial stains in 1910, has recently shown the selective bacteriostatic action of gentian violet and other dyes and, still more recently, Young[9] and those working with him have called attention to the bactericidal properties of mercurochrome and have used all these dyes intravenously in a variety of septic conditions. A large number of papers have appeared; from 1910 to 1923 there were 306 articles dealing only with the quinine and acridine derivatives.[10] It is obviously impossible to review all the material presented in the time available. I shall only refer to a few very recent articles.

A paper read last autumn by Carrick Robertson[11] presented a number of case reports of patients treated by intravenous injections of eusol. In his first case there had been sepsis following furunculosis. No mention is made of the site or extent of the lesion. In another, a most unfortunate accident had apparently occurred, an intra-peritoneal abscess spreading from the pelvis to the lumbar gutters had followed a simple ventral suspension. There was also an abscess in the abdominal wall. These foci were opened and drained but the patient continued very ill. Intravenous injection of eusol was fol-

lowed by a chill, a temperature of 106 and by prompt recovery. In another instance, pneumonia was followed by empyema. The thoracic cavity was opened and drained. A lung abscess evidently followed, for the patient is described as lying face down over the side of the bed while foul smelling pus poured from his mouth. He was given an intravenous injection and recovered. I have referred to these reports without other comment than that they seem to me to show the unsatisfactory nature of the clinical evidence offered.

In a report of Young and Hill (*l.c.*) on seven patients treated intravenously by mercurochrome and five by gentian violet, the results are described as almost miraculous, the patients being "snatched from the jaws of death." In a staphylococcus septicæmia in an infant there were multiple abscesses. The child is described as almost moribund; there were three positive blood cultures. The desperate condition of all the patients described is the most striking feature. Recoveries are reported in several cases of far-advanced terminal septicæmia. The blood is described, in each instance, as sterilized by the chemical. Brill and Myers,[12] however, report that in five cases the intravascular injection of mercurochrome and gentian violet in no way interfered with the progress of the general septic infections. The organisms reported in their cases were streptococcus, staphylococcus and colon bacillus. Meleney and Zau,[13] in January of this year, drew the conclusion from carefully carried out tests that the bacterial inhibiting action of neutral acriflavine within the body of the rabbit is so slight against the hæmolytic streptococcus, even in lethal doses of the dye, that it is not a legitimate intravenous medicament and that it has a distinctly harmful effect, especially on the cells of the liver and kidney.

On the medical service at St. Luke's Hospital, gentian violet, mercurochrome and aciflavine have all been administered intravenously in patients suffering from endocarditis with positive blood cultures of streptococcus viridans. None of the patients showed an improvement that could be fairly attributed to the medication. All four of the patients eventually died. The characteristic reaction after the injection was regularly seen.

There can be no question of this powerful reaction following the intravenous injection of certain chemicals; the chill, temperature, diarrhœa, appearance of the patient; all suggest a violent disturbance. One cannot dismiss the evidence presented of rapid recovery. But how often does it occur; how much is due to the bactericidal action of the drug, how much is due to its toxic effect on the body cells? It should be borne in mind that shortly after its introduction into the blood the chemical comes in contact with the cells of the reticulo-endothelial system, which we have referred to as concerned in the defense mechanism of the body, and almost certainly profoundly influences them. May it not be that at times substances are liberated that are harmful to the bacteria? Is not the action dependent on how much the drug stimulates or conserves the natural defense mechanism of the body?

At other times, may not some of the chemicals introduced produce various degenerative changes in the cells of the liver, the spleen and the kidney?

Dramatic reports of collections of heterogeneous clinical material is not convincing. Shall we speak, in coming years, of the sterilization of the blood or the poisoning of the body cells by the intravenous injection of certain of these chemicals? We have seen that contamination of the blood stream occurs under a variety of conditions. In many cases blood cultures show simply showers of bacteria; the absence of bacteria in the blood stream often indicates but examination between showers. Many so-called septicæmias terminate with startling suddenness untreated.

It should be possible to present the reports of experiments on a large series of animals with the characteristic lesions of generalized infections from microbes, with controls that show the arrest of the infection and recovery after the intravenous injection of the various chemicals used. This has been done in many instances in the study of the quinine and acridine derivatives. Patients with ulcerating lesions on the heart valves and bacteremia seem to me to offer the most suitable clinical material for study. The streptococcus, the staphylococcus and, rarely, the gonococcus, have all been observed as exciting agents. The lesion is local, accessible to the antiseptic; in the early stages the blood already possesses properties harmful to the bacteria and, although in the mild cases there are periods of remission, this disease is progressive.

The only microörganisms so far successfully combated in the human being by chemicals are the inciting agents of malaria and syphilis. Although there is much disagreement about the proper classification of the true spirochæte, it may be said that neither belongs to a group of true bacteria. The plasmodium of malaria is one of the pathogenic protozoa and the zoologist, Schaudinn, the discoverer of the treponema pallidum, placed this organism also in a group with the protozoa. In neither instance do we speak of sterilizing the blood. We speak of curing or arresting the disease.

The point I wish to emphasize is that in the generalization of infection a very complex process is passing on in the body. The presence of microbes in the blood is but one phase or part of this process. To speak of the blood as infected in the sense that the cellular tissue is infected in a spreading phlegmon is erroneous and misleading. To speak of the blood being sterilized by the intravenous injection of a chemical as a test tube containing a broth culture is disinfected, is equally misleading and erroneous.

BIBLOGRAPHY

[1] Hobo, T.: Pathogenesis of Osteomyelitis. Acta Scholæ Med., Univ. Imp., Kioto, 1921, vol. iv, p. 1. (Bibliography.)

[2] Wyssokowitsch, W.: Ueber die schicksale der in's blut injicirten mikroorganismen. im korper der warmblüter. Zietsch. für Hygiene, 1886, vol. i, p. 3.

[3] Cheyne, Watson: Trans. of the Path. Socy. of London, 1879, vol. xxx, p. 560.

[4] Anderson, H. M., and Richardson, G.: Septicæmia in Gunshot Wounds. Brit. Jour. of Surg., 1918, vol. v, p. 393.

[5] Legrain, Pierre: Septicemies au cours de l'evolution des blessures de guerre. Theses, Paris, 1917–18.

[6] Lenhartz, H.: Die Septischen Erkrankungen, 1903, p. 462.

[7] Ballinger, E. G.: 606, or Dioxydiamedoarsenobenzol. N. Y. Med. Jour., 1910, vol. xcii, p. 1157.

[8] Churchman, J. W.: The Selective Bacteriostatic Action of Gentian Violet and Other Dyes. Jour. of Urology, 1924, vol. xi, p. 1.

[9] Young, H. H., and Hill, J. H.: The Treatment of Septicæmia and Local Infections by Mercurochrome 220 Soluble and by Gentian Violet. Jour. A. M. A., 1924, vol. lxxxii, p. 669.

[10] Laqueur, E.: Die neuren chemotherapeutischen präparate aus der chininreihe und aus der akridinreihe, 1923. (Bibliography.)

[11] Robertson, Carrick: Intravenous Injections in Septic Conditions. Surg., Gyn. and Obst., 1925, vol. xl, p. 218.

[12] Brill, L. C., and Myers, H. B.: Mercurochrome 220 Soluble and Gentian Violet. Jour. A. M. A., 1925, vol. lxxxiv, p. 879.

[13] Meleney, F. L., and Zung-Dau Zau: Action of Acriflavine on the Blood and Certain Tissues of Rabbits. Jour. A. M. A., 1925, vol. lxxxiv, p. 337.

FAT EMBOLISM*

WITH STUDY OF TWO FATAL CASES

By Arthur W. Elting, M.D.
and
Charles E. Martin, M.D.
of Albany, N.Y.

It has long been known that free liquid fat may under certain conditions gain access to the blood-vessels and be transported in the blood stream. Fat in this form, of course, is to be more or less sharply distinguished from fat in the minute particles of emulsification or saponification, which plays little, if any, important rôle in the production of embolism. Fat embolism is essentially a surgical complication and usually occurs as a sequel to trauma, especially of the long bones or fatty structures of the body. In any instance in which fat is set free from ruptured fat cells, more or less embolism may result, the symptoms of which will depend not only upon the amount of fat which enters the blood stream, but also upon the localization of the fat emboli in the capillaries.

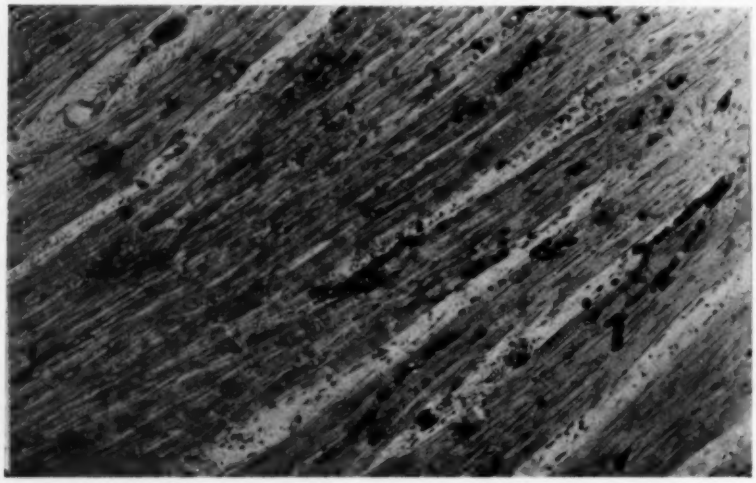


Fig. 1.—Case I. Heart. Scharlach R. and hæmatoxylin, showing numerous fat emboli, congestion and interstitial œdema.

Fat gains access to the circulation mainly through ruptured blood-vessels, but it is also probable that a small amount of fat may reach the circulation through the lymphatics by way of the thoracic duct. In the great majority of instances it is probable that the amount of fat entering the circulation is small and the localization not serious, so that few or no symptoms may ensue and no suspicion of the condition be had. In a smaller number of cases, but probably far more frequently than is generally recognized, fat emboli do produce symptoms which are usually attributed to other

* Read before the American Surgical Association, May 5, 1925.

causes, and in a still smaller number these symptoms are of great severity, and death ensues. Comparatively few correct clinical diagnoses of fat embolism have been made, and the pathologists, too, have undoubtedly overlooked the condition in many instances.

The object of this paper is to call to the attention of the surgical profession a condition of great importance, and in our judgment of relatively frequent occurrence, and to present the clinical picture and the pathological findings in two cases which have been carefully studied. Historically, much has been written about fat embolism, chiefly by the German pathologists beginning with Virchow in his classical work on embolism in 1862. Zenker, in 1862, observed the first case of fat embolism of the pulmonary capillaries in man, and during the succeeding years many articles were written and much experimental work done, chiefly on the continent. During the past few years certain American writers have given especial attention to this subject. The most complete survey of the literature, together with the most exhaustive study of the condition made up to that time was the article published by Warthin in 1913 in the International Clinics. To Warthin's summarized observations and conclusions practically nothing of importance has since been added. It is a striking fact that this condition seems to have been almost entirely overlooked by American surgeons, and the references to this condition in American surgical literature are singularly lacking and inaccurate.

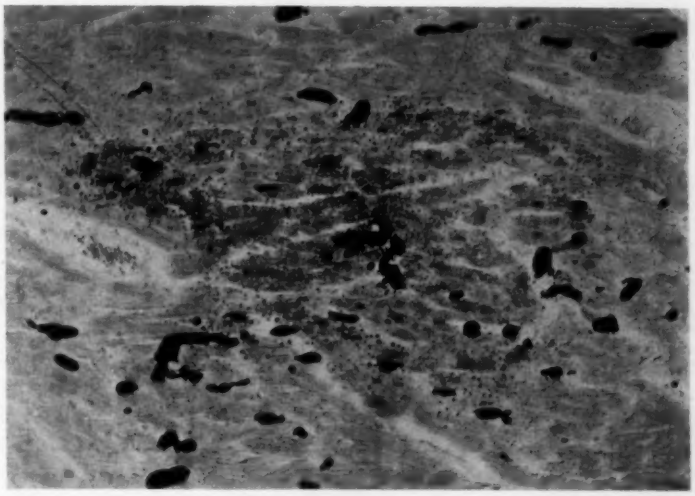


FIG. 2.—Case I. Heart. Osmic acid preparation. Colony of fat emboli with muscle fibres undergoing fatty degeneration.

CASE I.—J. M. H., aged twenty, a strong, healthy, athletic young man, whose past history was negative, was riding on the front seat of an automobile beside the driver at about 3 A.M., October 12, 1924, when the car crashed into a telephone pole, and the patient sustained closed fractures of both femora in the middle thirds. He was transported with all possible care to the Albany Hospital, where he was admitted to the surgical service about two hours after the accident. Retentive dressings were applied with the minimum of manipulation and the patient given a small dose of morphine. The patient was carefully examined by Doctor Elting at 10 A.M., at which time the temperature was normal, the respirations 20, and the pulse 100. There was considerable swelling and ecchymosis of both thighs, but no manipulation was indulged in. There was

some evidence of contusion over the lower abdomen in the region of the symphysis pubis, but no definite fracture could be demonstrated. There were no abrasions of any part of the body.

The patient seemed perfectly normal mentally, conversed rationally and expressed himself as feeling quite comfortable. There was no evidence whatever of shock and no disquieting symptoms. The patient's condition remained about the same until 3 P.M., when he began to complain of increased pain and became quite restless. He was given a small dose of morphine, which lessened the complaints and restlessness somewhat, but soon after this he became quite excited and irrational, which state in a few hours was followed by the onset of stupor. During the night this developed into a deep coma, from which the patient could not be aroused. Coincident with this was a rise in temperature and an increase in the pulse and respiratory rates.

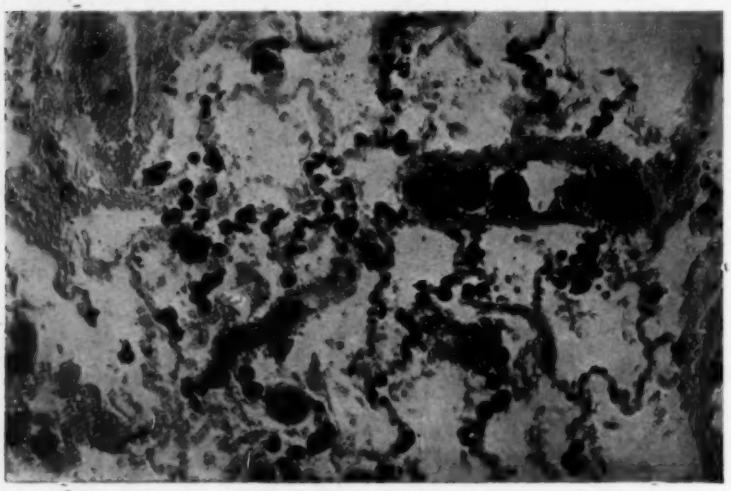


FIG. 3.—Case I. Lung. Osmic acid preparation. Fat emboli lodged in most of the smaller vessels.

When seen at 10 A. M., October 13, the patient was quite comatose with typical Cheyne-Stokes respiration. The temperature was 103, pulse 140, and respirations 28. Cyanosis and dyspnœa were pronounced. A lumbar puncture was done, and 22 c.cm. of normal spinal fluid under normal pressure was withdrawn. A diagnosis of cerebral fat embolism was made by Doctor Elting, and the patient was seen by Doctor Archambault, whose neurological note was as follows: "The patient is profoundly comatose, and no response occurs to any form of sensory stimulation. The upper extremities are flaccid and inert, but the tendon reflexes are present and of symmetrical amplitude. The eyeballs occupy the midplane. There is no strabismus, and the pupils moderately contracted are equal and reactionless. The eye grounds show perfectly normal findings. The breathing is of the typical Cheyne-Stokes type."

The patient remained in a comatose state with temperature rising to 105°, pulse 150, and respirations 30, until 7.30 P.M., when he died, approximately 40 hours after the accident. A urinary examination was negative, but unfortunately no special examination for the presence of fat in the urine was made, nor was the sputum examined for the presence of phagocytic cells containing fat. No skin petechiæ were observed during life.

Autopsy performed by Drs. L. J. Early and C. E. Martin, one and one-half hours post-mortem.

The body is that of a young, white male adult, 178 cm. long. Both femurs are fractured in the upper portion of the lower third, and the thighs are considerably swollen and contused. There are contusions and abrasions over the chest, buttocks and legs. Petechial hemorrhages are noted on the chest, arms, thighs and back.

The pleural cavities contain no fluid. The lungs are firm and do not collapse. The pleural surfaces are dotted with petechial hemorrhages, up to 6 mm. in diameter. Both lungs are extremely œdematous, and from the cut surface a thin, blood-stained fluid

drips. In either lung are several irregular hemorrhagic areas, 1 to 2 cm. in diameter and having a lobular distribution.

The pericardial cavity contains 50 c.cm. of a clear yellow fluid. Scattered over the epicardial and endocardial surfaces, but most abundant in the right ventricle, are numerous petechiæ 1 to 2 mm. in diameter. They also occur in the myocardium, where they are often surrounded by a narrow, yellow, opaque zone.

In the pelvis is an extensive subperitoneal hæmatoma. It covers the superior surface of the bladder and continues up over the brim of the pelvis well into the tissues of the posterior abdominal wall. The hæmatoma is most marked over the superior ramus of the right pubis, which is fractured. The bone is fragmented, dislocated, and the edges much roughened.

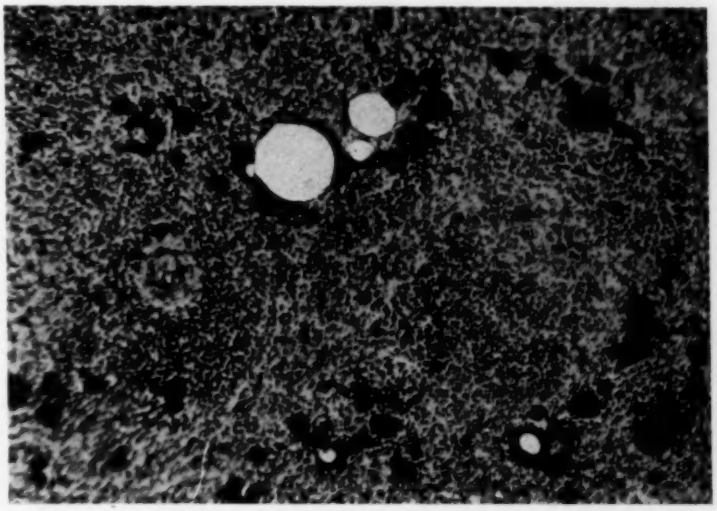


FIG. 4.—Case I. Spleen. Scharlach R. and hæmatoxylin, showing tendency for the emboli to group themselves about the periphery of the Malpighian bodies.

Pin-point hemorrhages scattered throughout the mucosa of the entire intestinal tract. In caecum are numerous streaky mucosal hemorrhages.

The pancreas is normal in the gross. Near the tail of the pancreas is a lymph-node, 1 cm. in diameter, showing much central caseation. The liver weighs 1780 gms. The cut surface is opaque, and the markings are indistinct. The gall-bladder and ducts are normal. The weight of each kidney is 150 gms. The vessels at the junction of the cortex and medulla are injected. The adrenals appear normal. In the mucosa of the bladder, mostly about the neck, are numerous small hemorrhages.

Brain: The weight of the brain is 1580 gms. There is the slightest suggestion of a cerebellar pressure cone, and the uncus projects into the interpeduncular fossa somewhat more prominently than normal. There is no other gross evidence of œdema, and no hemorrhages are seen.

Microscopic Examination.—Heart: There are numerous small areas of hemorrhage in which large numbers of fat emboli may be seen. The emboli often appear as long cords, and their diameter varies with that of the vessel in which they are lodged. The cells surrounding small groups of emboli often show considerable fatty degeneration. Phagocytic cells are not noted in such areas. Interstitial œdema and congestion are extreme. These changes are most marked in the left ventricle.

Lungs: Fat emboli are exceedingly numerous in the lungs. The alveolar walls are congested and most of the capillaries are stuffed with fat. A small amount of free fat is present in the alveoli. The alveoli are, in most instances, filled with transudate, but there is also considerable hemorrhage. There is a small amount of hæmosiderin in the alveoli, some of which has been phagocyted. There is an acute bronchiolitis and also small patches of early bronchopneumonia. The exudate consists almost entirely of polymorphonuclear leucocytes, a small amount of fibrin and a few macrophages.

Spleen: Congestion and hemorrhage are extreme. Fat emboli, which are scattered throughout are, however, most numerous and largest about the periphery of the lymphoid follicles.

Gastro-intestinal tract: There is œdema and congestion of the submucosa in every portion of the intestinal tract. Fat emboli are most often seen in the small capillaries of the mucosa. The cells of the gastric mucosa are secreting a large amount of mucus, much of which has been deposited on the surface. There is an occasional small area of submucosal hemorrhage.

Pancreas: There is marked interstitial œdema. The islets of Langerhans are congested, swollen, and in many the capillaries are stuffed with fat.

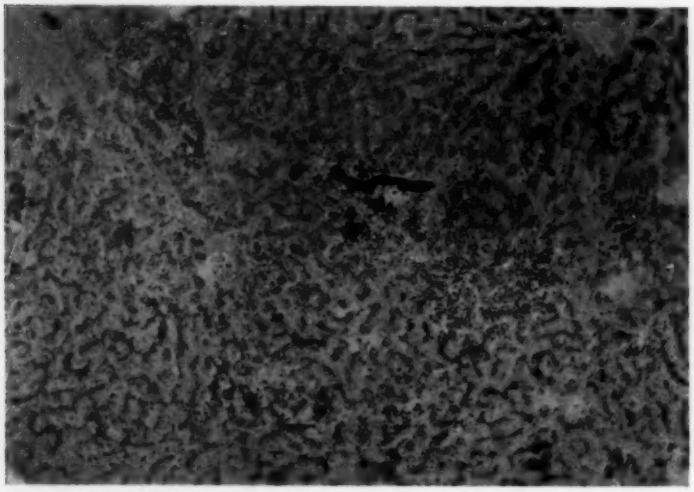


FIG. 5.—Case I. Liver. Osmic acid preparation. A few emboli and marked fatty metamorphosis, which is most marked along the bile capillaries.

Liver: Congestion is extreme and most marked about the central veins. Small droplets of fat are abundant in the liver cells along the bile capillaries. Fat emboli are numerous and most often seen in the capillaries of the periportal spaces.

Kidneys: The glomerular capillaries contain long cords of fat and are distended with red blood-cells. There is cloudy swelling of convoluted tubules. There are many small areas of hemorrhage, particularly in the pyramids. Many fat emboli are lodged in the extra-tubular capillaries.

Adrenals: The adrenal vein contains numerous variously sized fat droplets. Similar emboli are found in the cortex, the cells of which show fatty degeneration. The affected areas in the cortex appear to be the result, at least in some instances, of the plugging of a single vessel of the end artery type.

Bladder: There is a large amount of hemorrhage into the retro-peritoneal connective tissue. In the submucosa and muscularis, œdema and congestion are quite marked. Fat emboli are frequently seen in the mucosal vessels.

Genitalia: Spermatozoa are present in the seminal vesicles and emboli are occasionally noted in the mucosa.

Lymph-nodes: The vessels in the substance of the lymph-nodes are extremely engorged. Fat emboli are numerous and most often located immediately beneath the capsule in the peripheral lymph sinuses. The node removed from near the tail of the pancreas shows tuberculosis.

Brain: Sections from the frontal, temporal, parietal and occipital lobes, motor area, motor speech area, basal ganglia, corpus callosum, optic chiasm, pons, region about the Sylvian aqueduct, floor of the fourth ventricle, various levels of the bulb, upper cord and cerebellum are examined. Emboli and areas of focal necrosis are found in every section. One particularly large area is found in the hypoglossal nucleus. In most instances there is vacuolization, destruction of myelin and fragmentation of the axons. The cells are shrunken and pycnotic. Fat emboli are numerous in and about

these areas. There is little or no phagocytosis. Areas of degeneration are seldom seen in the fibre tracts. The remainder of the brain tissue is extremely œdematous.

CASE II.—W. L., aged twenty-one, was a healthy young man of good habits. At 2 A.M., on April 29, 1923, he fell from a window, a distance of 30 feet, and struck on the pavement, sustaining a closed fracture of the left hip and a compound comminuted fracture of the right humerus. He was removed at once to the Troy Hospital, where he was seen by Doctor Elting at 10 A.M. The fractures were carefully immobilized and the patient removed to the Albany Hospital, where he was admitted to the surgical service at 12 noon on May 1. At that time he appeared to be somewhat pale and shocked but quite rational. The temperature was 98.8°, pulse 120, and respirations 23. The patient was placed in a fracture bed and extension applied to the left leg. The right upper arm presented an irregular wound about 10 cms. in length, situated on the external surface at about the mid-region of the arm and just over the site of fracture of the humerus. Wet antiseptic dressings were applied and the arm immobilized. There were numerous contusions of the chest and abdomen, but none of the head. The patient was restless and uncomfortable, but his condition remained fairly satisfactory. The temperature was practically normal for three days, and the pulse ranged from 90 to 100. The respirations were about 25, and there were no cerebral, cardiac or respiratory symptoms of any significance. For the first two days the patient was restless and difficult to manage at times, but on the third day the general condition was much improved. He was less restless, quite rational, and sleep was more natural. Early on the fourth day the temperature rose in a few hours to 104°, the pulse to 140, and the respirations to 35. The patient was at first restless and delirious, but later in the day he became stuporous and during the night lapsed into coma. When seen on the morning of the fifth day the temperature was 105°, the pulse 150, and the respirations 40. He was quite comatose, with Cheyne-Stokes respiration. The reflexes were abolished. The breathing was labored. Cyanosis was pronounced, and there was evident pulmonary œdema. The pulse was weak and the arterial pressure low. The eye grounds were negative. The wound on the right arm was unchanged except for a slight amount of sero-purulent discharge. Cultures from this wound made on the fourth day showed a hæmolytic streptococcus and a hæmolytic staphylococcus aureus. Blood cultures made on the fourth day were negative. Urine examination showed some albumin, a few granular casts and a few red blood-cells. Unfortunately no special examination was made for free fat in the urine. The temperature, pulse and respiration remained elevated. The coma continued, and the patient died on the evening of the fifth day, approximately four and three-fourths days after the accident.

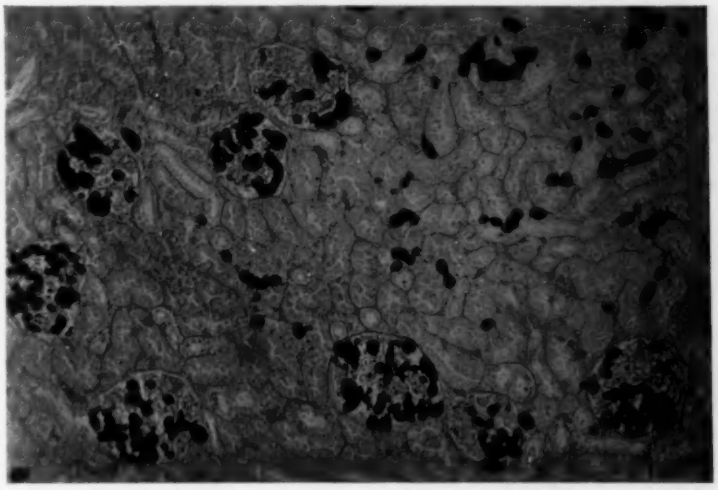


FIG. 6.—Case I. Kidney. Osmic acid preparation. Fat emboli in the glomeruli and extra-tubular capillaries.

Autopsy performed by Drs. V. C. Jacobson and L. Sutton, one and one-half hours post-mortem.

The body is that of a well-developed and well-nourished young, white, male adult, 183 cm. in length. There are numerous petechial hemorrhages in the skin and conjunctivæ. These hemorrhages are most marked over the anterior abdominal wall, chest and arms.

Over the outer aspect of the right arm is a laceration 3 x 1 cm. It is several centimetres in depth, and from it a blood-stained, turbid fluid exudes. The tissues for several centimetres about are œdematous and indurated. A comminuted fracture of the humerus, with much crepitation, can be easily felt just beneath the surface. Numerous blebs with a reddish base are scattered over the outer surface of the lower half of the arm. The circumference of the right arm is 30 cm. and of the left arm 25 cm.

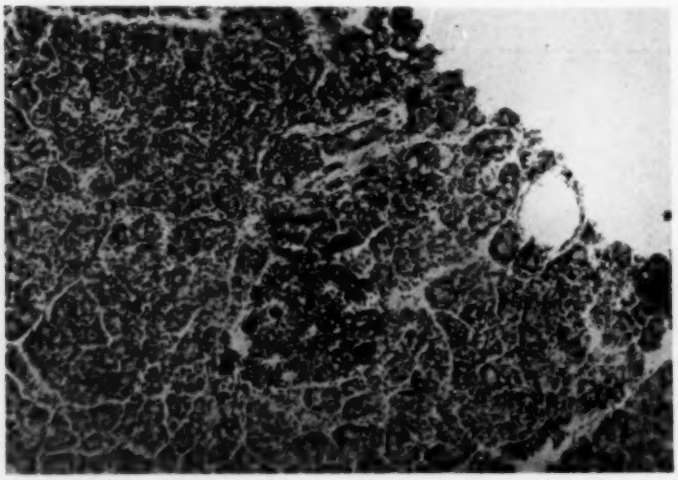


FIG. 7.—Case I. Pancreas. Scharlach R. and hæmatoxylin. In centre is an islet of Langerhans, swollen, congested and containing fat emboli.

The left femur is fractured at about its middle. Measuring from the anterior superior spine of the ileum to the internal malleolus, the left leg is 91 cm. and the right leg 99 cm. in length. Beginning 4 cm. below the right iliac crest is a large area of ecchymosis and yellowish discoloration 29 x 14 cm. There are various ecchymoses of the right knee, right leg and left leg.

An extensive hemorrhage in the pelvis covers the bladder, sigmoid and psoas muscles. There is about 10 c.c. of free blood in the pelvis. In the anterior abdominal wall is a diffuse retro-peritoneal hemorrhage and the peritoneum shows a few small lacerations. The mesenteric lymph-nodes are enlarged, some of them being 2½ cm. in diameter.

The left pleural cavity contains 50 c.c. of thin, reddish-brown fluid and the right cavity 10 c.c. of blood. The pericardial cavity and heart are apparently normal.

The lungs are acutely congested throughout, but more so in the lower lobes. Projecting above the surface of the lower right lobe is a bleb 3 cm. in diameter, filled with blood. Within the substance of the lung are several similar pools of blood. There are no large hemorrhages in the left lung, but digestion of considerable tissue about the hilum has occurred from a perforation in the œsophagus. Many of the bronchioles contain a mucopurulent material.

The spleen (370 gms.) is grayish-red, firm, and the lymphoid follicles prominent. The lower two-thirds of the œsophagus is thin and necrotic. An agonal perforation which communicates with the mediastinum and left pleural cavity has occurred in the middle third.

The liver weighs 2150 gms. The cut surface is opaque. In the right lobe are several linear fractures, 4 to 6 cm. in length, filled with clotted blood. The surrounding tissue is necrotic. The kidneys are congested. The adrenals, bladder, genitalia and aorta appear normal.

The brain is congested and œdematous. There are pin-point hemorrhages diffusely distributed throughout the gray and white matter of the cerebrum, cerebellum, pons and basal ganglia.

Microscopic Examination.—Heart: Fat emboli are scattered throughout the myocardium. In many instances they form small groups about which the muscle fibres have undergone fatty degeneration. Rarely is there any phagocytosis. There is congestion and interstitial œdema. Leucocytic thrombi are present in several of the coronary vessels and necrosis of the adjacent muscle fibres has occurred.

Lungs: Massive hemorrhage has disrupted the lung tissue, the blood filling the alveoli and bronchi. Fat emboli are exceedingly numerous, being located principally in the alveolar capillaries. There is a small amount of free fat in the alveoli. The alveolar walls are intact. Hæmosiderin-laden phagocytes are numerous. There is a slight purulent bronchitis and polymorphonuclear exudate about some of the hemorrhages.

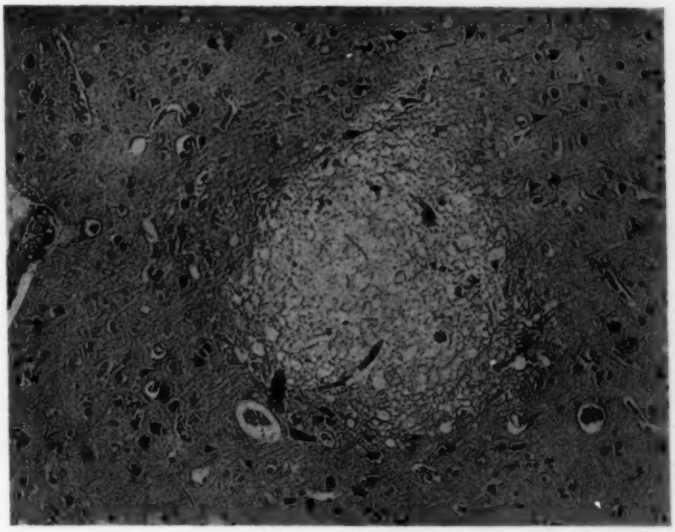


FIG. 8.—Case I. Frontal lobe. Hæmatoxylin and eosin. Focal necrosis with vacuolization and rarefaction of the area. The cells are shrunken and pycnotic. There is no phagocytosis.

Spleen: There is an acute splenitis of the hyperæmic type. Fat emboli are numerous and located chiefly in or about the lymphoid follicles.

Liver: Fat emboli are numerous in the small vessels of the periportal spaces. Fine fat droplets are abundant in the liver cells along the bile capillaries. There are large areas of necrosis, sometimes involving whole lobules or the periportal portions, but mostly of irregular size and shape. Phagocytosis by polymorphonuclear leucocytes is in progress in small foci. Rents in the liver-tissue, probably from trauma, are filled with blood.

Pancreas: Fat emboli are most numerous in the Islets of Langerhans. There is slight œdema and congestion.

Gastro-intestinal Tract: Fat emboli are most often seen in the capillaries of the submucosa. The mucosa of the duodenum shows a mild acute inflammation.

Kidney: Fat emboli are abundant in the glomeruli, which are swollen, congested and often contain an excess of polymorphonuclear leucocytes. There is an acute tubular nephritis and interstitial leucocytic infiltration is conspicuous in many places in the medulla and cortex.

Adrenal: The cortex has undergone considerable fatty degeneration with necrosis and disappearance of many cells. There are many emboli, some of large size, principally located deep in the cortex.

Skin of Arm: There is a purulent inflammation of the skin and subcutaneum, with tracts of exudate dissecting between the muscle and fascia. Fat emboli are unusually abundant, some large vessels being completely occluded.

Brain: Several sections of the cerebral cortex, cerebellum, pons and bulb are examined. In all sections fat emboli are present. There are many small foci of necrosis. Some foci show simply rarefactions with destruction of myelin and pycnosis of the cells. In other areas hemorrhage alone is most prominent. Some foci of necrosis are surrounded by a rim of hemorrhage. Phagocytes are not common. Often the centre of a

necrosed area is occupied by a vessel plugged with fat. Emboli are less prominent in the fibre tracts. Several small hemorrhages are noted in the floor of the fourth ventricle and in the cerebellum.

NOTE.—Shortly before death, cultures of the material from the wound in the right arm showed the presence of hæmolytic streptococcus and hæmolytic staphylococcus aureus. The autopsy findings were regarded as typical of streptococcus septicæmia, although unfortunately a blood culture was not made after death. The focal lesions so widely distributed in the body, the bronchopneumonia with hemorrhage and the bacteriological findings in the arm wound seemed sufficient for a diagnosis of probable septicæmia.

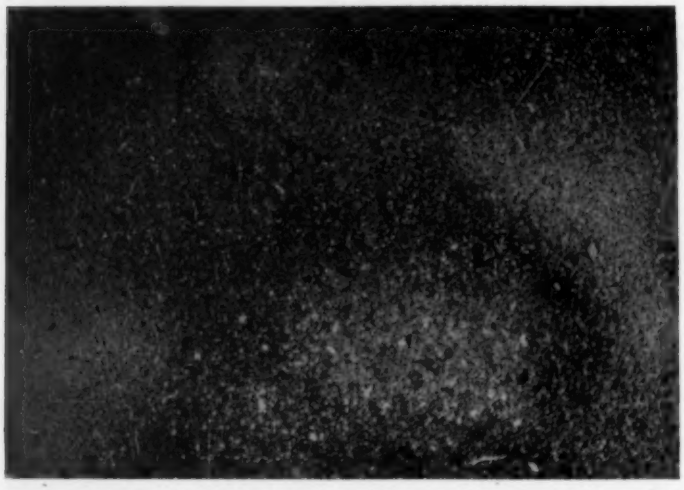


FIG. 9.—Case I. Motor area. Osmic acid preparation. Semi-confluent foci of necrosis.

After Case I was revealed as one of fatal fat embolism, Case II was studied from the same angle and proved to be one of fat embolism, the focal lesions being not due to bacterial emboli, but to occluding fat droplets.

There has been a remarkable tendency to regard cases of fat embolism as cases of shock, and it would appear that this term has borne the brunt of the incorrect diagnoses. W. T. Porter, of Boston, in 1917, both asserted and demonstrated that the so-called shock following war wounds of the long bones was in the great majority of instances due to fat embolism. His experiments conclusively proved that all of the symptoms of shock could be readily caused by fat embolism of the lower structures of the brain, the clinical and pathological pictures presented by his experimental animals being exactly the counterpart of those observed in the human subject. Porter further demonstrated in 1919, that the injection of a very small amount of olive oil into the vertebral artery of animals would cause fat embolism of the vaso-motor centre, thus bringing about vaso-motor paralysis and shock. Porter even went so far as to declare that fat embolism is the most frequent cause of wound shock upon the battlefield. The amount of fat which may be found in the capillaries is at times astounding, and it is difficult to conceive of where all the fat comes from. There is, furthermore, no definite relationship between the amount of trauma and the extent of the fat embolism. As a rule the trauma is rather severe, but in some instances it is comparatively trivial.

It is not altogether uncommon for surgeons to lose cases of fractures of the long bones a few days after the accident when everything appeared to

be going well. The temperature, pulse and respiration begin to rise. The patient becomes at first restless, then perhaps delirious, then comatose, and death ensues. The surgeon usually regards these as cases of shock, toxæmia, infection or concussion, but they are practically always cases of fat embolism.

It is probable that fat embolism in the absence of infection is the most common cause of death after fracture of the long bones.

Warthin has especially emphasized the medico-legal importance of fat embolism after injuries in which the usual diagnosis by the coroner's physician is shock, apoplexy, alcoholism, concussion, heart disease, etc. It may be positively stated that fat embolism occurs only during life, and its presence in the body after death is presumptive, and in the majority of cases, positive evidence of trauma before death.

FIG. 10.—Case I. Occipital lobe cortex. Scharlach R. and hæmatoxylin. Numerous fat emboli. An area of focal necrosis is surrounded by several large emboli.

Fat emboli are bland, and their effects are purely mechanical. For their production three conditions must be fulfilled:

1. The fat must be liberated from the fat cell.

2. It must be liquid and accessible to the circulation.

3. There must be some force to drive it into the blood-vessels.

Trauma and the accompanying hemorrhage, with at times infection, easily bring about the liberation of fat from the cell. The second condition is met by the patent vessels in the bone-marrow, and Haversian canals, which show much less tendency to close after trauma than do other vessels. Hemorrhage, œdema, inflammation, manipulation or tight bandages may readily supply the increased pressure to force the free fat into the vessels. The amount of fat which may be, and in fatal cases usually is, deposited in the capillaries is apparently out of proportion to what would be regarded as the normal amount of fat in the traumatized area. Some observers have thought there must be some other source for the free fat, but none has as yet been demonstrated.

In an effort to determine whether or not the fat content of the organs was actually increased, the lungs and spleen of the two cases of fat embolism and the same organs of five other diseased states were extracted. The lung was chosen because most of the fat must at some time pass through or lodge

in it. As the spleen may be considered a filter in the systemic circulation, it was also extracted.

The tissue was first dehydrated over concentrated sulphuric acid, then powdered, weighed and mixed with fat-free plaster-of-Paris. Using sulphuric ether as solvent, the fat was extracted by means of the Soxhlet apparatus. Extraction was continued for at least 20 hours in every case. After extraction the filtrate was diluted to a known volume [usually 100 c.c.] and 10 c.c. placed in a weighed crucible. The ether was then evaporated and the crucible again weighed. From this the fat content of the whole and the percentage composition of the dehydrated specimen was computed. The following are the estimations.

FIG. 11.—Case I. Section lateral to the Sylvian aqueduct at the level of the third nerve. Scharlach R. and hæmatoxylin. Large focal necrosis with many emboli in and about it.

Disease	Lungs	Spleen
Fat embolism [Case I]	45.5%	52.5%
Fat embolism [Case II]	35.4%	29.1%
Extensive superficial burns [lye]	3.5%	3.4%
Acute alcoholic poisoning	11.7%	8.7%
Fracture of skull with maceration of brain	13.8%	12.1%
Peritonitis following bullet wound	9.1%	23.8%
Peritonitis following perforation of jejunum	8.1%	19.0%
Normal content [Wells]	17.3%	14.2%

This, so far as we are able to learn, is the first actual demonstration of the quantitative increase of fat in the organs of cases dead of fat embolism and confirms the microscopical findings. What is true of the lungs and spleen will naturally hold true of the other organs.

Welch states that fat embolism is the commonest form of embolism. It is our feeling that all fractures involving the fatty marrow of bones are probably associated with some degree of fat embolism, but that in the great majority of cases the embolism is so slight that no symptoms are produced, while in a lesser number of cases true symptoms do result which are usually incorrectly interpreted.

In all of these cases recovery takes place, and in only a few of them may it be possible to prove the diagnosis. In the cases that result fatally,

however, a carefully performed autopsy will always demonstrate a most striking and characteristic picture and one that cannot possibly be confused with any other known pathological condition.

Fat embolism may be caused—

1. By all forms of trauma affecting the marrow of bones, especially fractures.

2. All kinds of operations upon bones, especially the so-called orthopædic operations.

3. Trauma, inflammation, necrosis or operation upon fatty tissue in any part of the body.

FIG. 12.—Case I. Floor of the fourth ventricle. Hæmatoxylin and eosin. Large area of rarefaction occurring in the nucleus of the hypoglossal nerve. The ganglion cells show various stages of degeneration.

Fat embolism resulting from other causes is rare and of pathological interest only, as there are rarely any definite symptoms.

The vast majority of cases of fat embolism are due to trauma of the bone and are most frequently observed after injury to the bones containing the greatest amount of fatty marrow, as the femur, tibia and humerus. The osteoporotic bones of the aged and the atrophic bones of any age, containing more than the normal amount of fat, are naturally of etiological importance, but it is especially apt to occur after serious injury to the long bones of the healthy young adult, particularly in the third decade. The fat may pass into the blood stream rapidly and in sufficient quantity to produce symptoms almost immediately, although in the majority of instances the accumulation of the fat in the capillaries is a slower process, and the symptoms do not appear for some hours, it may be several days after the trauma. Tight bandages, manipulation, movement and jarring are factors which may favor fat embolism.

The oft-repeated and generally accepted observations of the lessened shock observed in the late war, as the splinting and transportation of cases

of fracture became more expert, skilful and expeditious, furnish in our judgment not only clinical evidence of the importance of fat embolism as a cause of the so-called shock in these cases, but also striking evidence of the importance of prophylaxis in possible cases of fat embolism. There can be little doubt that many cases of death from so-called post-operative or traumatic shock are cases of fat embolism, for unless autopsies are conducted with this possibility in view, many, if not most cases, of fat embolism will be overlooked.

The manner in which fat droplets produce embolism has been much discussed. Gauss, by adding olive oil to citrated human blood, claims to have increased its viscosity approximately four times. This was confirmed by Bissell. In attempting to repeat these experiments we were at once confronted with the extreme difficulty of keeping the fat droplets in the emulsion of sufficient size to form emboli in a capillary tube. When they were of large size and could be induced to enter the capillary tube, the findings agreed with those of Gauss and Bissell, and even when a single droplet of fat was made to enter a capillary tube ahead of a column of normal salt solution, the time for the passage was increased to the same degree as was originally found. Obviously the apparent increase in viscosity was due, not to the increased viscosity of the whole mixture, but to the presence of the fat alone. In an effort to make the fat remain emulsified, it was shaken in a mechanical shaker, and to aid in the emulsification ground glass was added. When this was done and the viscosity tested it was found not to be increased over that of the salt solution without fat. In this case the emulsion was very fine and did not settle out.

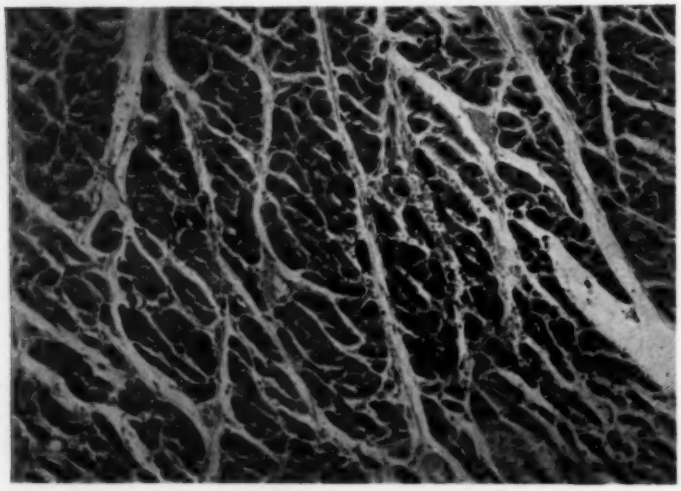


FIG. 13.—Case II. Heart. Scharlach R. and hæmatoxylin. Area in centre undergoing fatty degeneration, several emboli, œdema and congestion.

The latter finding is, of course, not new and only serves to bear out what has long been known in lipæmia, as of diabetes, where there is an extremely fine emulsion of fat and blood and in which fat embolism does not occur. So it is that from these experiments we believe that while the progress of fat emboli through a capillary may be slow or even halted, it is due to the greater viscosity of the fat alone, rather than to the increased

viscosity of the whole fluid. These experiments were performed both with olive oil and human fat. Olive oil has a somewhat greater viscosity than human fat.

The characteristic lesions of fat embolism are widespread throughout the body, and a knowledge of the pathology is absolutely essential for a proper interpretation of the clinical phenomena. At the site of the injury or operation liquid fat is found often mixed with blood or pus. This fat enters the more or less patent veins, especially those of injured bones, aided by the increased tension at the site of the injury. In addition to the fat which enters the blood-vessels, fat may also enter the lymphatics, pass through the regional lymph-glands, and reach the venous circulation through thoracic duct.

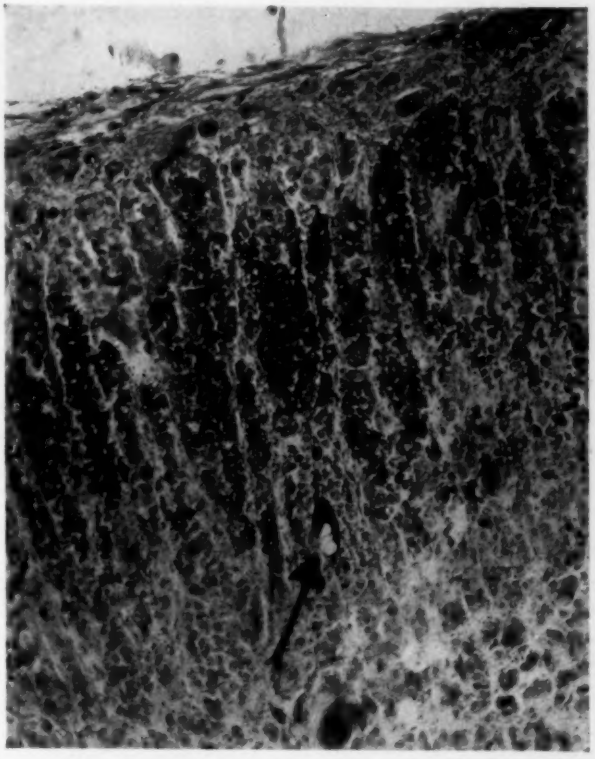


FIG. 14.—Case II. Adrenal. Scharlach R. and hæmatoxylin. Extensive fatty degeneration of the cortical cells. The arrow points to a large embolus.

The lesions which occur depend upon the amount and the distribution of the fat which enters the circulation. The fat appears to be first arrested chiefly in the pulmonary capillaries, and in many instances it may go no further, but as the fat increases in pulmonary capillaries it passes into general circulation, then it is that a widespread distribution takes place; and there are no organs or tissues which may not show fatty embolism.

It is probable that a considerable amount of fat can be tolerated in the capillaries without necessarily producing serious lesions. If the fat enters the heart in large amounts, the result may be very similar to that observed in air embolism. The heart action may not be sufficient to drive the fat into the lungs, and serious embarrassment of the heart and death may ensue. The heart action and function are also seriously and even irreparably impaired by myriads of capillary fat emboli in the terminals of the coronary arteries, causing large numbers of small cardiac infarcts, and it is probable that most of the cardiac symptoms are due to this condition. Liquid fat may be observed in the right heart, and numerous petechial hemorrhages occur

beneath the epicardium and endocardium, surrounded in some instances by a small rim of light yellow discoloration. Microscopically, the emboli seem to group themselves in colonies, and around these emboli the heart muscle shows fatty degeneration and anæmic infarcts.

The pulmonary capillaries receive by far the largest number of fat emboli. The lungs at autopsy are rather firm, and a thin blood-stained fluid drips from the cut surfaces, while fat droplets may be seen in the blood-vessels. Œdema, congestion, hemorrhage and rarely hemorrhagic infarction are seen. Subpleural hemorrhages are often observed. Microscopically the lungs present in addition, when stained with Sharlach R or osmic acid, capillaries greatly dilated and filled with fat, which may be in a globular or confluent form.

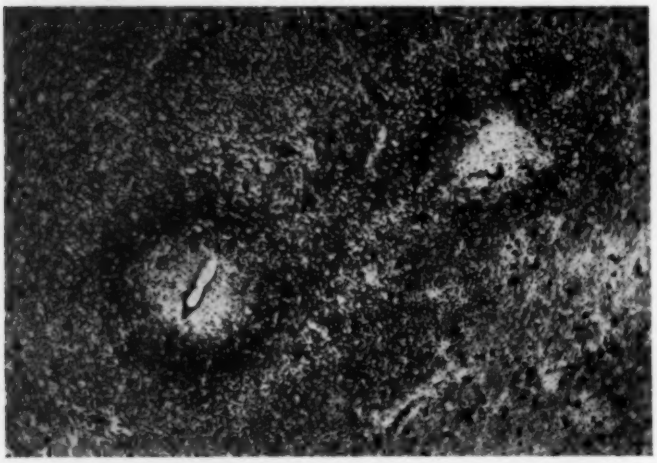


FIG. 15.—Case II. Cerebral cortex. Scharlach R. and hæmatoxylin. Two areas of focal necrosis, each containing a fat embolus.

The brain in the gross usually is the picture of cerebral œdema. Scattered miliary hemorrhages are evident on the surface, as well as throughout the substance of the brain. Microscopically, minute hemorrhages are found around small vessels filled with fat. The surrounding brain tissue shows more or less pronounced degeneration characteristic of focal necrosis or infarction.

These lesions adequately explain the early cerebral irritation followed by the paralysis so characteristic of the cerebral syndrome.

The spinal cord presents similar, though less striking lesions.

The liver shows passive congestion due to the heart impairment, and there are minute areas of focal necrosis. Fat emboli may be observed in the capillaries surrounded by areas of cell degeneration.

The spleen is usually swollen and congested. The fat emboli are particularly abundant and tend to group themselves around the Malpighian bodies.

The kidneys are congested. The fat emboli are found especially in the glomerular capillaries, and are much less evident in the vessels about the tubules. There are often fatty casts in the tubules. Small hemorrhages may be present, but degeneration of the renal cells is usually slight.

The petechiæ observed in the skin are the result of minute hemorrhages around capillaries filled with fat.

The pancreas shows numerous fat emboli, chiefly in the capillaries of the islands of Langerhans.

The adrenals show many emboli in the capillaries of the cortex, with marked degeneration of the surrounding cells.

The thyroid, striated muscles, and in fact all the other tissues show more or less pronounced capillary fat embolism.

The excretion of the fat is largely through the kidneys, and numerous clinicians have noted its presence in the urine. Fat is also excreted through the activity of the phagocytes, and as Warthin first emphasized, many of these fat-laden phagocytes appear in the sputum, a diagnostic point to which he called especial attention. Through the intestine, bile and other channels the fat-laden phagocytes may make their escape. A very small amount of the fat may be taken up by certain of the fixed cells of the body, and it is probable that a small portion of it is also disposed of through the processes of oxidation and saponification.

FIG. 16.—Case II. Inferior olivary body. Scharlach R. and hæmatoxylin. Capillaries of the convolutions containing numerous emboli.

A study of the clinical features of fatal cases of fat embolism shows the striking uniformity with which certain symptoms appear. There seems to be a fairly well defined clinical picture and one which should be recognized. Following a trauma most commonly associated with fracture of a long bone, or an operation upon the bones or fatty tissues, there is usually a period of well-being during which the patient's condition is fairly satisfactory. This euphoria may last from a few hours to a week or more.

As a general rule the symptoms due to fat embolism are first observed on the second or third day following the trauma or operation, although they may occur within a few hours or be deferred for several days. As a rule the earlier the symptoms present, the more serious the case, and the more certain the fatal termination.

The symptoms may be classified into two general clinical syndromes, although these merge into one as the fatal termination is approached: (1) The cardio-respiratory syndrome, and (2) the cerebral syndrome. Some writers attempt to differentiate a cardiac from a pulmonary syndrome, but we believe from a study of the clinical phenomena and the pathological findings that they should be classed as one symptom complex in which, unlike

most writers, we regard the cardiac phenomena of more importance as a rule than the pulmonary. The chief symptoms are dyspnœa, cough, cyanosis, pulmonary œdema, occasional pulmonary hemorrhage, rapid and irregular pulse with a low arterial and high venous pressure. There may be cardiac dilatation and precordial distress. The temperature is at first as a rule not elevated, but as the case progresses, it may reach 103° or more and usually continues high until death. Cheyne-Stokes respiration is often present. Moist râles are often heard over the lungs from evident pulmonary œdema, and at times the sputum is very profuse. As a rule there is little impairment of the pulmonary resonance associated with pure fat embolism.

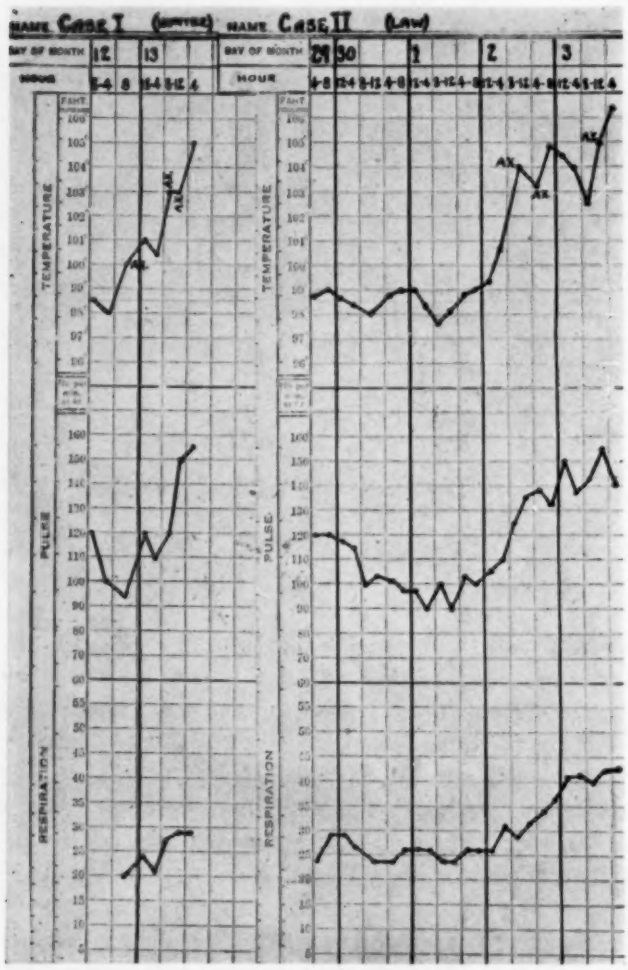


FIG. 17.—Charts of the two fatal cases.

The cardio-respiratory syndrome is the one which usually develops first, but if the case progresses, the second or cerebral syndrome comes strikingly into evidence, although it may appear within a few hours after the trauma or operation. The important features of the syndrome are at first restlessness, often headache, more or less delirium, sometimes hallucinations, then drowsiness, stupor, and finally coma, which persists until death. The reflexes may or may not be abolished, and there may be spasms, tremors or convulsions. The earlier cerebral symptoms are those of cerebral irritation coincident with the occurrence of the showers of emboli, while the later symptoms are those of paralysis, due to the rapid cerebral degeneration. There are no signs of increased intracranial pressure, and the eye grounds are usually normal. Embolism of the respiratory centre accounts for the Cheyne-Stokes respiration. Embolism of the heat regulating mechanism

may explain much of the elevated temperature, while embolism of the vasomotor centre may cause many of the apparent symptoms of shock. The pupils are usually rather small but equal. Petechiæ may be observed in the skin but are more or less obscured by the cyanosis and are at any rate of relatively late appearance.

The symptoms described characterize the fatal cases, but they may be seen in milder form in cases that recover, and it is quite evident that this picture closely resembles what is usually regarded as shock. It is probable that careful urinary examination will always reveal some fat in the urine in severe cases of fat embolism, and it may be present in mild ones. Warthin and others have also emphasized the importance of fat in the sputum as an aid in diagnosis. In cases associated with head injury, the diagnosis may be very difficult during life, but it should not be at autopsy, as it appears to have been in the past.

The course of fat embolism may be rapid or slow. Some cases are so rapid as to be described as apoplectiform, with death in a few hours, while others may persist for days or weeks to end in death or recovery. As a rule the longer the patient lives, the better the prognosis. In well-developed cases of fat embolism, especially those of the cerebral type, the prognosis is almost invariably bad, and the great majority of all severe cases die. One cannot judge the mortality by the literature, for most of the cases reported have been fatal ones, while it is probable that a much larger proportion recover but are not recognized as such and are classified under various headings. Post-operative or post-traumatic diagnosis of bronchitis and pneumonia may not infrequently be rather fat embolism.

The treatment of fat embolism is chiefly prophylactic. All cases of trauma, especially fractures, should have absolute rest, and all unnecessary movement or manipulation should be avoided. Transportation of such a case should be with the greatest care. Tight bandages should not be used. All unnecessary trauma should be most carefully avoided in operations, whether of orthopædic or other character. None of the methods of treatment so far proposed seems to be of any especial value, the reason for which becomes apparent when one studies the pathology of the condition. Venesection, saline injection and thoracic duct fistula are the chief measures hitherto recommended, but the results of their employment are by no means encouraging. Symptomatic treatment is in general about all that can be proposed. It is hoped, however, that as surgical attention is directed more and more to the importance of this condition, effective methods of treatment may be devised.

REFERENCES

Welch, William H.: Albutt's System of Medicine, chapter "Embolism," which Contains Reference to Virchow's and Zenker's Contributions.

Warthin, Aldred S.: Inter. Clin., Phila., 1913, 23 s., vol. iv, p. 171.

Porter, William T.: Bost. M. and S. J., 1917, vol. clxxvi, p. 248. *Ibid.*, 1919, vol. clxxx, p. 531.

Gauss, H.: Arch. Int. Med., 1916, vol. xviii, p. 76.

Bissell, W. W.: Surg. Gyn. and Obs., 1917, vol. xxv, p. 8.

OPERATIVE TREATMENT OF ANGINA PECTORIS*

By Harry Hyland Kerr, M. D., C. M.
of Washington, D. C.

The interest of the medical world has recently been aroused by the attempted surgical relief of angina pectoris. There are recorded in the literature sixty-three cases in which various surgical procedures have been performed to relieve this ailment. With the additional eight cases herewith reported, we have sufficient data from which to gather certain tentative deductions.

The rationale of the operative procedures used is based on Sir Clifford Allbutt's theory of the nature of angina pectoris. Contrary to the older teachings, he believed that the disease is primarily in the first portion of the aorta and that the heart itself or its coronary arteries may be entirely uninvolved. The characteristic lesion is an aortitis involving the outer, rather than, the inner coats of the vessel. Through the fibres of the cardiac plexus, this aortitis sets up a reflex spasm of the aorta when subjected to strain. The root of the aorta first feels the brunt of increased heart action and the nerve fibres in its adventissue are irritated. Through the afferent nerve tracts this irritation stimulates the centres in the cord or the medulla. Through the efferent fibres the muscular walls are thrown into contraction. The subjective manifestation of this spasm is the agonizing substernal pain referred down the left arm. It is probable that the pain always accompanies a contraction of the vessel. The attack can be arrested and relief obtained if the vessel is made to dilate. Clinical experience indorses the theory, in that the most efficacious drugs used during the attacks are the vaso-dilators as nitroglycerine or amyl-nitrate. As these drugs relieve the attacks, surgery has attempted to prevent them. As the attack is the manifestation of an aortic spasm, the result of a physiological reflex, it can be prevented by dividing either the efferent or the afferent fibres of the reflex arc.

The heart is ennervated by the superficial and deep cardiac plexuses with their branches, the anterior and posterior coronary plexuses. The superficial cardiac plexus is made up of the left superior cardiac nerve from the left superior sympathetic ganglion and branches from the vagus and filaments from the deep cardiac plexus. It is distributed to the base of the aorta, the atria, and the anterior coronary plexus. The deep cardiac plexus is made up of other cardiac nerves from the right and left sympathetic ganglia and the vagi.

A greater part, if not the greatest part, of the nerve supply of the root of the aorta is from the superficial cardiac plexus. The sympathetic portion of this plexus comes principally from the left superior cervical sympathetic

* Read before the American Surgical Association, May 6, 1925.

ganglion through the left superior cardiac nerve. This nerve, therefore, plays a large part in the sympathetic ennervation of the first portion of the aorta. The depressor nerve is considered an afferent nerve of the heart. In the rabbit it occurs as a separate nerve, but in man its anatomical identity is not clearly made out. Hofer in describing his operation of the division of the depressor nerve for the relief of angina pectoris advises the resection of all branches of the vagus and superior laryngeal nerve passing into the thorax. Stimulation of the depressor nerve uniformly causes a drop in blood-

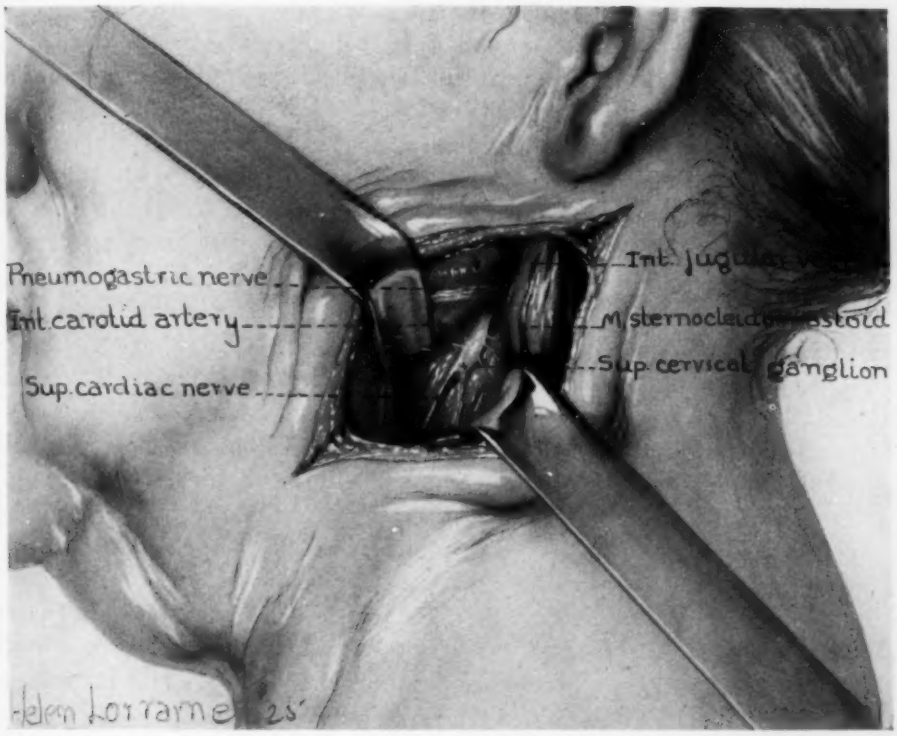


FIG. 1.—Operative treatment of angina pectoris; exposure of the superior sympathetic ganglion by an oblique incision in front of the sterno-cleido-mastoid muscle. The superior cardiac nerve is seen passing forward and downward under the carotid sheath which has been retracted forwards.

pressure in experimental animals. If it acts in the same way in man, it is probable that the depressor nerve is included in the human vagus sheath, since irritation of the vagus near the base of the skull produces the same phenomenon. Division of either of these nerve tracks, the sympathetic or depressor nerve, would theoretically interrupt the reflex arc connecting the heart with the central nervous system.

Francois Frank suggested division of the sympathetic nerve tracks to the heart for the relief of angina pectoris. Wenkleback suggested division of the depressor portion of the vagus with the same object in view. Both procedures have been carried out in a limited number of cases with results encouraging enough to tempt us to continue our surgical efforts to relieve this terrible malady.

Seneque discusses, in a recent article, twenty-three cases operated on for angina pectoris and concludes that resection of the inferior cervical and first thoracic ganglia is the operation of choice. More recently, Mont Reid, analyzed a larger group of cases and comes to the same conclusion.

From a careful study of all cases reported and from a small personal experience, I am of the opinion that the simple avulsion of the superior ganglion offers as good results with far less risk to these cases with already damaged circulatory systems.

To simplify the study of the results of the various operative procedures, we may divide them into three groups according to the nerve track divided.

In the first group, all the sympathetic nerves going to the heart are divided especially on the left side. This original operation of Jonnesco is a procedure of considerable magnitude, requiring especial retractors and electrically lighted instruments. Though it can be performed under local anæsthesia as in Case IV of this series, general anæsthesia has usually been resorted to. This operation or modification thereof has been performed twenty-six times. There were five deaths. Ten cases were completely relieved thereby and six partially relieved. In three, no relief was obtained and in one, the result was not stated.

The second group comprises the cases treated by division of the depressor nerve. This is a small group consisting of the cases reported by Hofer. Most anatomists consider the depressor nerve a fasciculus of the vagus and its identification must be difficult or impossible in some cases.

Of the twelve cases so treated, death resulted in two, complete relief in four, and partial relief in three. In two others the depressor nerve could not be found and no relief was obtained. In one the result was not stated.

The third group are the cases in which the left superior cervical sympathetic ganglion or the left superior cardiac nerve was divided. This procedure was first advocated as a relief for angina pectoris by Coffey and Brown, of San Francisco, and may be termed the American operation.

Thirty cases, including the eight cases herein recorded, have been so treated. The results are as follows: Deaths 5, complete relief 17, partial relief 6, failure 2. It is thus seen that the American operation gives the highest percentage of relief.

Considering the risk entailed in these cases, the advantages of the American operation over the others is most marked. The American operation is a simple anatomical dissection which should never require a general anæsthetic. The original exposure of the superior cervical ganglion advocated by Coffey and Brown was through an incision behind the sterno-cleido-mastoid, but I believe the operation described by C. H. Mayo in 1914 is much the superior. Briefly its steps may be described as follows:

An oblique incision is made in a fold of the neck beginning under the left mastoid process and running forward and downward three or four inches.

The anterior border of the sterno-cleido-mastoid muscle is dissected, taking care not to injure the spinal accessory nerve in the upper angle of the wound. The carotid sheath containing the carotid artery, internal jugular vein and pneumogastric nerve is then exposed and retracted forward. The superior cervical ganglion is found on the longus capitus muscle opposite the transverse process of the second cervical vertebra in loose alveolar tissue. It is best freed by gauze dissection when its connection upwards and downwards are easily made out. The superior cardiac nerve is a very constant and large branch coming off the anterior inferior part of the ganglion and passing downward and forwards under the carotid sheath. The only difficulty that might arise in the dissection is the differentiation between the vagus with its bulb in this neighborhood and the elongated sympathetic ganglia. A wider dissection, demonstrating the extension and connections of the nerve in question, will clear up this point.

FIG. 2.—Operative treatment of angina pectoris, anæsthesia produced by division of branches of the cervical plexus.

In the ten operations I have performed, I have observed an interesting phenomenon that may prove of value in making this differentiation exact. When the vagus nerve is grasped with smooth thumb forceps and gently squeezed the systolic blood-pressure drops and, with the release of the nerve, the blood-pressure resumes its former level. The pulse rate is not altered by this manipulation. Squeezing, or even tearing out the superior cervical ganglion, has no marked effect on the blood-pressure. This observation suggests that the depressor nerve is included in the vagus sheath at this level. I have demonstrated it in all but one of my ten operations. I submit it for what it may be worth.

In the eight cases in which I performed the so-called American operation, the left superior sympathetic ganglion has been removed according to the foregoing technic. In two cases the operation was repeated on the right side and in one, at a third seance, the middle cervical and stellate ganglia were also avulsed under local anæsthesia. In five cases complete relief from the angina was obtained, in two partial relief, and in one no relief. In those cases still having a residue of their pain in the form of a substernal ache on exertion or

effort, the relief is so great that they are restored to sub-normal activity and feel immensely repaid for their short stay in the hospital.

The permanent results of superior sympathectomy are anæsthetization of the area above the oblique scar, from division of the superficial branches of the cervical plexus. There is also produced an enophthalmos and contraction of the pupil on the operated side. This latter phenomenon always appears as soon as the ganglion is avulsed, but may disappear in a few hours or days. It usually persists.

In conclusion it is fair to state that interruption of the nerve pathways to or from the heart has a remarkably beneficial effect in true cases of angina pectoris.

The results of all operations show a relief either complete or partial in sixty-six per cent., a mortality of 17 per cent.; a failure in only 10 per cent.

The American operation of resection of the superior cervical sympathetic ganglion under infiltration anæsthesia gave as good results as the more difficult and dangerous operations proposed and should have no mortality.

It is interesting to note that no case of angina pectoris operated upon has since died of the disease as far as can be ascertained.

REPORT OF CASES

Case I.—A. W., female, age fifty-seven. First seen January 31, 1924. Patient was a short, rather stout woman whose blood-pressure was 200/90. The examination of her blood was normal, the Wassermann negative, urine negative except for a very faint trace of albumin. Renal function test and the blood chemistry were within the normal limits. Her weight was 140 pounds.

Examination of the heart was negative; there was no enlargement and no cardiac murmurs. X-ray of the chest was negative.

Her present illness began twenty months before admission with a characteristic attack of angina pectoris. While walking up a slight incline she was seized with a knife-like pain behind the sternum, running down both arms. This experience has been repeated innumberable times since, growing worse until she finally was confined to her room by the attacks. The slightest exertion or the ingestion of anything but a small amount of liquid nourishment produced an attack. The pain responded promptly to nitroglycerine.

On February 7, 1924, under general anæsthesia the left superior cervical sympathetic ganglion was removed. Following this procedure she was free from pain for two days, but it recurred on the third day, after her mid-day meal. On the fourth day she had another typical attack which was immediately relieved by nitroglycerine.

Since her pain was bilateral, February 14, the right superior cervical sympathetic ganglion was extirpated. She was discharged from the hospital, February 23, 1924, without a recurrence. Shortly thereafter while walking she had a pain which she describes as similar to her old pain. The pain was not nearly as severe and was not referred down her arms. Her subsequent history shows occasional attacks of refrosternal ache which are never referred down the arms. She has had no pain whatever for the past two months. She is able to go out and around and leads her usual life.

Case II.—W. E. P., age fifty-four. First seen February 26, 1924. He gave a typical history of angina pectoris of a few months' duration. The pain was referred only to the right arm and was precipitated by the slightest exercise or injection of food. His father died from heart trouble.

He had typhoid fever at the age of twelve years. Negative venereal history. He

used to be a heavy drinker but has been a total abstainer for the past seventeen years. In the past ten years his weight has markedly increased and he has had dyspnœa on exertion. He has never had any œdema of the legs or feet.

Physical examination. The patient is a large heavy man weighing about 200 pounds. His complexion is pasty and his mucous membranes are pale. The heart is found to be distinctly enlarged and a loud systolic murmur is heard over the entire cardiac area and into the left axilla. His blood pressure is 200. The physical examination is otherwise essentially negative.

On March 3, 1924 a left superior cervical sympathectic ganglion was extirpated under local anæsthesia. His recovery was very prompt and satisfactory. He has never had any return of his anginal pain and a note of March 22, 1924, states that he walked a mile without discomfort. This was nineteen days after operation.

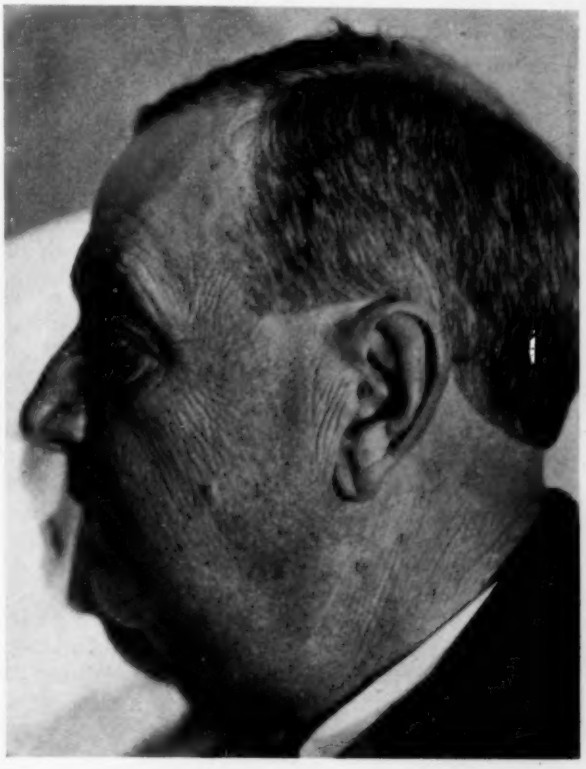


FIG. 3.—Operative treatment of angina pectoris; inconspicuous scar resulting from superior sympathectomy.

CASE III.—R. H., age sixty. First seen March 17, 1924. Present illness began January 1, 1924, with typical severe attack of angina pectoria. Severe pain behind the sternum referred down the left arm with a feeling of suffocation and impending death. These attacks recurred and became more severe so that he was either in bed or confined to his room.

He was a rather robust man of the florid type. His blood pressure was 140 and there was no evidence of arterio-sclerosis. Physical examination was essentially negative. X-ray of the chest showed no abnormalities of the heart or great vessels. The heart sounds were clear.

March 20, operation under general anæsthesia, typical block incision with extirpation of the superior cervical sympathetic ganglion and its branches. Operative recovery good. On the third day he had a sharp pain in the lower right quadrant of the abdomen. Leucocytes 13,000. His temperature rose gradually through the next several days and the leucocytes mounted to 20,000. By this time a patch of localized dullness and suspicious râles confirmed Doctor Acker's diagnosis of pneumonia. This, however, cleared up promptly and he went to Atlantic City. He had no return of his angina in any form after operation.

In May, 1924, six weeks after operation, he had an attack of apoplexy of the left side which left him hæmiplegic and completely aphasic. His recovery from this has not been satisfactory, though he is up and around, he has never been able to speak since the stroke. He has never had an attack of angina since operation and assures me by signs that he never has it now.

CASE IV.—E. B. P., age fifty-five. First seen October 22, 1924. He gave a

history of recurring attacks of retro-sternal pain referred down both arms for the past two years. He has never been a vigorous man, had a severe attack of appendicitis with prolonged post-operative drainage five years ago, since which time his health has been decidedly impaired. When the attacks of pain began it is said that his heart showed no abnormalities on physical examination. Since then, however, he has gradually progressed to a state of cardiac decompensation. He has been unable to lie down and spends most of his time standing by his bed-side. There is œdema of both lower extremities, involving the scrotum and both fore-arm and hands. The pulse rate is about 95. The heart is markedly enlarged, there is a systolic murmur heard over the precardium and left axilla. The aortic sound is not clear. The blood-pressure is 150. He takes nitroglycerine repeatedly. When he feels an attack coming on he puts a hypodermic tablet under his tongue and is usually able to remove it within a few seconds with the attack averted. He has been thoroughly digitalized on two separate occasions without any effect on his anginal pain or cardiac condition.

October 18, 1924 left superior cervical sympathectomy under local anæsthesia. There was some modification of his pain though it continued in lesser degree, but necessitating nitroglycerine. His pain was bilateral in distribution, so that October 25, a right superior sympathectomy was performed under local anæsthesia. Again his condition was not markedly changed and his pain continued both behind the sternum and down both arms.

November 19, one month after his first operation he was operated upon for the third time under local anæsthesia. The middle and stellate cervical ganglion of the left side were extirpated. This operation was extremely difficult because he was apprehensive during the procedure and took nitroglycerine several times. The procedure was carried out, however, without pain from the operative trauma.

Following this procedure his condition remained essentially unchanged. His retro-sternal pain continued and was referred to both arms as before. It was decidedly less severe than before the interference. Cardiac condition grew gradually worse, he was never able to lie down, his dyspnœa, tachycardia and œdema progressed and he succumbed in January, 1925, three months after his first operation.

In this case I consider that the operation was a failure. His angina was not controlled by operation, though it seemed to have been somewhat modified. He died from cardiac decompensation.

Case V.—C. H. F., male, age sixty-one. First seen March 7, 1925. The past history is negative except for a nervous breakdown about 30 years ago.

For the past three years he has had a feeling of soreness, distress and at times actual pain with a feeling of constriction in the upper chest and under the sternum. The pain is frequently transmitted down the arms, particularly the left. The attacks of pain have been increasing in the past few months. At present the pain is brought on by any exercise, eating or emotion. The patient is always relieved by nitroglycerine (1/200) placed under the tongue.

Heart examination eighteen months ago by Doctor Lee states: size normal, aortic arch not enlarged. First tone at apex of good muscular quality. Second pulmonic tone normal. Second aortic tone somewhat accentuated and slightly ringing in quality. A fairly loud rather harsh systolic murmur is heard at the second right intercostal space. It is heard faintly in the right supraclavicular region and at the midsternum. These aortic sounds were accentuated and the second aortic tone and murmur were increased when lying down after exercise. Cardiac response to moderate exercise good.

Examination at the present time is as above, except that the accentuated aortic tone and aortic systolic murmur are not illicited when the patient is examined at rest and are very slight after exercise. Physical findings in relation to the aorta are less marked, whereas the subjective symptom, pain, has become worse. The blood-pressure has remained fairly constant over the entire time, averaging about 140/80. X-ray of chest negative.

March 11, 1924, under local anæsthesia the left superior cervical sympathetic ganglion was extirpated. His convalescence was smooth and satisfactory.

Though he has had no severe attack of pain since operation, he has complained of some sub-sternal ache which has gradually diminished. At first he continued taking nitroglycerine (1/500) but as his distress gradually lessened he has practically discontinued his medicine.

The pain entirely disappeared two months after operation and has not recurred though he has resumed his former occupation.

CASE VI.—T. E. M., male, age fifty-two. First seen March 13, 1925. Present illness began in December, 1924, with an attack of pain in his chest radiating to the left arm. It passed off without assistance or medication. In January, 1925, he was awakened from a sound sleep at five o'clock in the morning with a typical attack of angina. During this attack his pulse was very fast and slightly irregular. He has never had another frank attack because, as soon as he feels one coming on, he takes nitroglycerine and lies down.

March 16, 1925, a typical left superior cervical sympathectomy was carried out under local anæsthesia. He had a satisfactory convalescence and up to the fourth day had no return of pain.

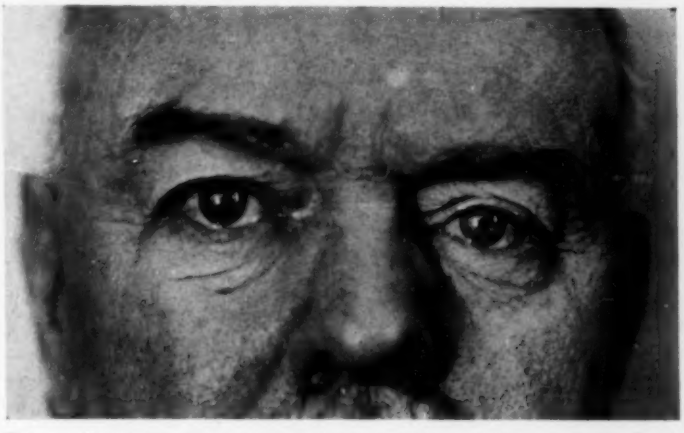


FIG. 4.—Operative treatment of angina pectoris; enophthalmos and unequal pupils produced by superior sympathectomy. This is commonly transient.

A letter dated April 20, 1925, a little over a month since operation, states, "I have had some pain in my chest. I suppose I have taken nitroglycerine about four times, which relieved me. I have taken some light exercise in my room with no discomfort. I feel better than I have done for six months prior to operation."

CASE VII.—G. D., female, age fifty-seven. First seen April 9, 1925. Seven years ago she had her first attack of severe subpectoral pain. She has had attacks more or less frequently since. For the last six months she has been confined to her room and after each attack she is compelled to stay in bed for several days. She states that she has been subject to high blood-pressure for a great many years. At present the reading is 220/110. She is a very stout woman. Her heart is somewhat enlarged and there is a loud systolic murmur heard distinctly in the aortic area and transmitted to the vessels of the neck. The diagnosis of the cardiologist, Doctor Lee, was arteriosclerosis, myocarditis with anginoid pains.

April 14, 1925, typical left cervical sympathectomy under local anæsthesia. She has had no pain since the operation. The blood pressure is decidedly lower. She has suffered from neuralgia of the left side of the head and left shoulder but has not been incapacitated thereby. She is able to climb stairs without retro-sternal discomfort.

CASE VIII.—M. S., female, age fifty. First seen April 13, 1925. In 1917, she had a very severe attack of "Flue" with shortness of breath and some cyanosis. This left her much debilitated. She has had attacks of migrane for years. In 1918, she had an operation for appendicitis.

In 1919, the patient had her first attack of angina. X-ray taken at that time showed a slight enlargement of the arch of the aorta. There was some dullness to percussion.

She was free from further attacks until about six months ago when she had a typical anginal attack. She has been having them more or less frequently ever since, having had five attacks in all.

The Wassermann is negative, urine analysis negative. Hæmoglobin 75 per cent. Coagulation time of blood 2 minutes.

X-ray interpretation is as follows: There is considerable fibrosis and calcification at the roots of the lungs and the aortic knob is unusually prominent, but there is nothing in the appearance that would represent an abnormality in a patient of this age. The heart is within normal limits.

April 14, 1925, typical left cervical sympathectomy. She left the hospital on the sixth day and up until the time of her leaving for her home she had had no return of her old pain. She has shopped, been to the theatre, and climbed stairs without the slightest discomfort.

REFERENCES

Arce, J.: Simana Med., Buenos Aires, 1924, vol. xxxi, pp. 936–938.

Bacon, J. H.: Jour. Am. Med. Assn., 1923, vol. lxxxi, p. 2112.

Brown, P. K.: Jour. Am. Med. Assn., 1923, vol. lxxx, No. 11, p. 1692.

Blackhall, Morrison A.: Brit. Med. Jour., 1920, vol. ii, p. 840.

Brit. Med. Jour., 1921, vol. i, p. 823.

Bruning, F.: Klin. Wchschr., Berlin, 1923, vol. ii, pp. 777–780.

Bruning, F.: Deutsche Med. Wchnschr., Berlin, 1923, vol. xlix, pp. 945–947.

Bruning, F.: Arch. f. Klin. Chir., Berlin, 1923, vol. cxxxi, pp. 484–501.

Borchard, A.: Arch. f. Klin. Chir., Berlin, 1923, vol. cxxvii, pp. 212–221.

Ceccarelli, C., and Campanacci, D.: Riforma Med. Napoli, 1923, vol. xxxi, pp. 1039–1042, Collected Papers of 1914, p. 335, C. Mayo.

Coffey, W. B., and Brown, P. K.: Arch. Int. Med., 1923, vol. xxxi, pp. 200–220.

Coffey, W. B., and Brown, P. K.: Arch. Int. Med., 1924, vol. xxxiv, p. 417.

Danielopalu and Hristide: Bull. et Mem. Soc. Med. d'hôp. de Paris, 1923, 3S, vol. xlvii, p. 6973.

Danielopalu and Hristide: Comp. Rend Soc. de trow, Paris, 1923, vol. lxxxvii, pp. 271–275.

Diez, J.: Rev. Assn., Med. Argent., Beunos Aires, 1924, vol. xxxvii, No. 231, Soc. de Med. intern, 5–33.

Florchen, H.: Arch. f. Klin. Chir., Berlin, 1924, vol. cxxx, pp. 68–92.

Henry, A. K.: The Lancet, London, 1922, vol. ii, p. 1395.

Henry, A. K.: Irish Jour., M. S. C., Dublin, 1924, 5S, pp. 157–167.

Halstead, A. E., and Christopher, F.: Jour. A. M. A., 1924, vol. lxxxii, pp. 1661–1664.

Hofer, G.: Ztschr. f. Hals-Nunsen, U Ohrench, Munchen, U Berlin, 1923, vol. vi, p. 68.

Hofer, G.: Wien. Med. Wchnscher, 1924, vol. lxxxiv, pp. 1356–1359.

Jonnesco, T.: Bull. Acad. de Med., Paris, 1920, vol. lxxxiv, pp. 93–102.

Jonnesco, T.: Cong. Franc de Chir. Proc. Verb. (etc.), Paris, 1920, vol. xxix, pp. 492–500.

Jonnesco, T.: Bull. Acad. de Med., Paris, 1921, vol. lxxxvi, pp. 67–71.

Jonnesco, T.: Bull. Acad. de Med., Paris, 1921, 3S, vol. lxxxvi, p. 208.

Jonnesco, T.: Presse Med., Paris, 1923, vol. xxx, p. 517.

Jonnesco, T.: Bull. Acad. de Med., Paris, 1923, 3S, vol. xc, pp. 168–174.

Jonnesco, T.: Presse Med., Paris, 1924, vol. xxxii, p. 138.

Jennings, C. G., and Jennings, A. F.: Med. Jour. and Record, N. Y., vol. xx, pp. 311–314.

Journal A. M. A., Chicago, 1924, vol. lxxxiii, p. 273.

Kingscote, E.: Med. Times, N. Y., 1924, vol. lii, p. 272.

Kingscote, E.: Brit. Med. Jour., London, 1924, vol. i, p. 914.

Kappis, M.: Med. Klin., Berlin, 1923, vol. xix, pp. 1658–1662.

Kamnitzer: Therap. d. Gegem., Berlin, 1923, vol. lxiv, p. 234.

Kohlerm, R., and vonder Weth, G.: Ztscher. f. Klin. Med., Berlin. 1923, vol. xcix, pp. 205–231.
Mortensen, M. A.: Battle Creek Bull., vol. xx, p. 18.
Odermatt, W.: Deutsche Ztscher. f. Chir., Lepzig, 1923, vol. clxxxii, pp. 341–354.
Pepper, O. H. P.: Prog. Med., Phila., 1923, vol. iii, p. 168.
Pleth, V.: Amer. Jour. Surg., N. Y., 1922, vol. xxxvi, p. 300.
Ransohoff, J. L.: ANNALS OF SURGERY, 1925, vol. lxxxi, p. 585.
Reid, M. R., and Friedlander, A.: Jour., A. M. A., 1924, vol. lxxxiii, p. 113.
Reid, M. R., and Eckstein, G.: Jour. A. M. A., 1924, vol. lxxxii, pp. 114–117.
Reid, M. R., and Andrus, W. de W.: ANNALS OF SURGERY, 1925, vol. lxxxi, p. 591.
Reid, W. D.: Jour., A. M. A., vol. xxxiii, p. 1528.
Stearling, A. E.: Bull. Med. Jour., London, 1921, vol. ii, p. 95.
Seneque, F.: Presse Med., Paris, 1924, vol. xxxii, p. 171.
Wenchebeck, K. F.: Brit. Med. Jour., 1924, vol. i, pp. 809–815.

ACUTE MASSIVE COLLAPSE OF THE LUNGS*

A DISCUSSION OF ITS MECHANISM AND OF ITS RELATION TO FOREIGN BODIES IN THE BRONCHI AND POST-OPERATIVE COMPLICATIONS

By Chevalier Jackson, M.D.

and

Walter Estell Lee, M.D.

of Philadelphia, Pa.

This term, acute massive collapse of the lungs, was given by the English Pasteur in 1908,[29] to a condition which he found post-mortem in children dying suddenly with nasal and pharyngeal diphtheria. Since this original description the condition has been found associated with many other lesions and the propriety of the term, acute massive collapse, has been questioned. Collapse of the lung, as usually employed, infers such a deflation of the alveolar tissues and bronchi as results from the positive intrapleural pressure of pneumo,- hydro,- and pyo-thorax. In this phenomenon of acute massive collapse of the lungs there is a deflation of massive and partial areas of alveolar tissues, but probably no collapse of the bronchi. The term atelectasis, or collapse of the alveolar tissues of the lungs, describes more accurately this condition, and we hope with Scott, Pancoast and other more recent contributors to the subject, that this term will eventually replace the original expression of Pasteur. However, in this report we will use the term collapse.

In 1910,[17] Pasteur stated that there was a close connection between the mechanism producing massive collapse of the lower lobes of the lungs, in what he thought was post-diphtheritic paralysis,[56] and that underlying pulmonary collapse following operative procedures. In 1914 he records a group of 201 post-operative pulmonary complications in which he recognizes 16 cases of massive collapse, or a proportion of 8 per cent.[16] It is of definite significance that all of these cases of pulmonary collapse followed abdominal operations. Since this report 48 cases have been recorded in literature, and in January, 1925, Scott[53] had collected 64 cases. In addition to this group we have had access to the unpublished records of 9 cases. Five of these cases occurred in the service of one of the authors.

Pasteur would have us confine this term to a condition of massive collapse in which the alveolar portion of the lungs is completely deprived of air. When incompletely airless he suggests the term "partial deflation." This seems to us unnecessarily confusing. Undoubtedly varying degrees of pulmonary collapse occur, and Briscoe[15] states his belief that a large majority of post-operative pulmonary complications are entirely due to varying degrees of pulmonary collapse. To us its clinical importance as a post-operative complication lies, not in the occasional massive collapse that is encountered,

* Read before the American Surgical Association, May 5, 1925.

but in the frequent partial collapse of varying degrees which occurs after certain types of operative procedures, trauma and other conditions of which we will speak later. Until the present time only massive collapse has been reported, but in the last six months we have been in more or less constant attendance at the post-mortem examinations at the Pennsylvania Hospital conducted by Dr. J. R. Paul, where he has demonstrated beyond question that partial pulmonary collapse is a very common condition in the lungs after death and that its significance has been overlooked by pathologists in the past.

The Usual Phenomena: Physical Signs.—From a few hours to as long as seven days after a surgical operation, usually abdominal, the patient suddenly presents symptoms of a catastrophe. It is impossible at first to localize the trouble. The thorax after a short time will engage one's attention because of the cyanosis which usually appears almost with the onset. Acute dilatation of the heart, coronary embolism, pulmonary embolism or infarction are the usual preliminary diagnoses. A more careful examination may suggest a pneumothorax. There may or may not be an increase in the respiratory rate sometimes reaching as high as 30 or 40. The pulse-rate and the respiratory rate, will, of course, be directly proportionate to the febrile reaction which in turn will be dependent upon the associated infections, as localized or generalized peritonitis. The physical signs in the chest are perhaps the most characteristic.

FIG. 1.—Patient Lee—Belk—Perkins, Bryn Mawr Hospital. Section taken from an area of massive pulmonary collapse of the lower lobe of the right lung. Collapse occurred three days after an operation for the relief of a strangulated left femoral hernia under local novocaine anæsthesia. Death occurred on the eleventh day after onset of pulmonary collapse.

Upon inspection there are diminished or even absent respiratory movements of the chest wall over the affected area. The intercostal spaces apparently are hollow and very much narrower than upon the normal side. The cardiac impulse is seen displaced toward the affected side (just the opposite to that found in pneumothorax or pleural effusion). The apex of the heart has a tendency to tilt outward and upward, so that the apex impulse may often

be felt in the axilla (this is particularly true when it occurs on the left side). In two of our cases, right-sided, it reached the right anterior axillary line and was first diagnosed by the house officers as dextrocardia (a very common preliminary diagnosis). The dome of the diaphragm on the affected side is abnormally high and immobile. The high diaphragm is readily detected by percussion in the left-sided cases. On the right side, however, percussion is not so reliable, but X-ray examinations yield unequivocal evidence both as to its position and immobility.

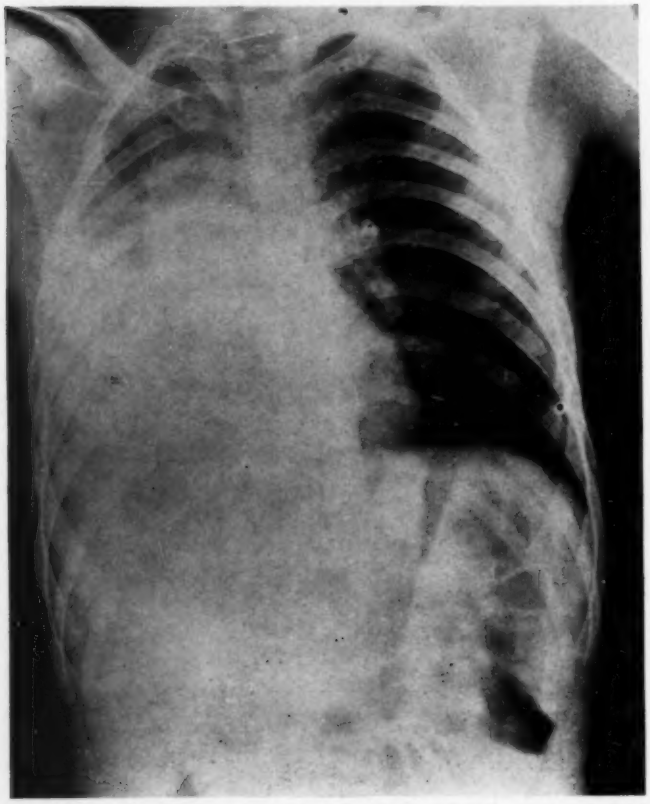


FIG. 2.—Charles L., patient of Drs. Walter Estell Lee, Gabriel Tucker, Harry Wilmer and Howard Geissler, Germantown Hospital. Picture taken three days after the drainage of an appendiceal abscess by Doctor Davis and ten hours after the onset of the clinical symptoms of acute massive pulmonary collapse. Massive collapse of the middle and lower lobes of the right lung. Partial displacement of the heart to the right. Displacement of the trachea to the right. Radiograph by Dr. Henry T. Thissell.

These findings are common to all cases, namely the physical signs which indicate a falling or pushing into the thoracic cavities of the surrounding structures, the mediastinum and diaphragm. Further analysis of the physical signs divide the cases into two distinct groups.

In both the dulness on percussion is present over the affected side and may extend as high as the clavicle; this is usually posterior, but it may be anterior. It corresponds to the area of the collapsed lung. The part of the chest cavity unoccupied by the collapsed lung is hyperresonant and may be tympanitic. In one group the vocal fremitus is diminished or absent, while in the other it is increased over the dull area. In the group in which the vocal fremitus is diminished or absent, the breath sounds are also diminished or absent, while in the second group the breath sounds are increased, tubular or amphoric in character and bronchophony and pectoriloquy are also extremely well marked.

This difference in the physical signs is probably dependent upon the patency of the bronchi. When there is a large proportion of air in them there

is an increase in the breath sounds and they may be loud, tubular or amphoric in character and bronchophony and pectoriloquy may be present. One will readily see that the physical signs in the lungs are those commonly attributed to pneumonic consolidation, but if anything, the signs are even more marked, especially the tubular and amphoric character of the breath sounds.

Probably the reason massive collapse of the lungs is so frequently overlooked is that these physical signs of its presence are at once regarded as conclusive evidence of the existence of pneumonic consolidation. Due attention to the other signs, particularly cardiac displacement, should make the diagnosis clear.

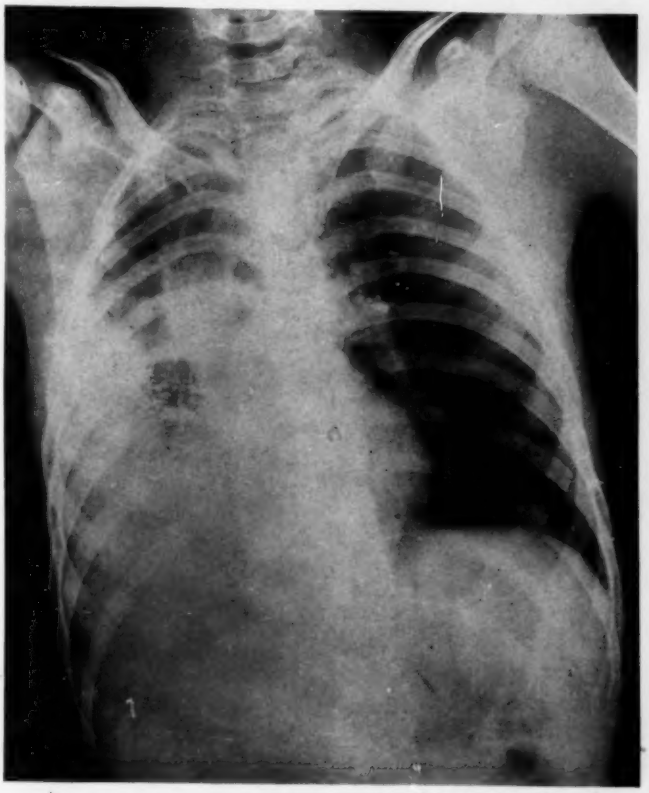


FIG. 3.—Charles L., patient of Drs. Walter Estell Lee, Gabriel Tucker, Harry Wilmer and Howard Geissler, Germantown Hospital. Picture taken twenty-four hours after the onset of the clinical symptoms of acute massive pulmonary collapse. A slight increase in the amount of air in the right upper lobe since the taking of the last picture, but the heart has moved further to the right. Radiograph by Dr. Henry T. Thissell.

In the type of cases in which there is dulness on percussion and diminished or absent breath sounds, the diagnosis is more difficult, unless adequate stress is laid upon the displacement of the cardiac impulse.

Broadly speaking, the type of case in which the bronchi are not patent is usually found in the early stage of the condition, while the patent bronchi are found in the later stage of lung expansion. In two of our cases the sounds of the transmitted voice when heard through the stethoscope were almost deafening. Cardiac displacement is the most characteristic physical sign and the condition cannot be diagnosed with certainty unless this sign is present.

This marked displacement of the heart is rarely, if ever, accompanied by a cardiac murmur. Though the displacement is mainly lateral in cases where the whole lobe is involved, the displacement is also upward so that the maximum impulse may be felt in the third interspace or behind the fourth rib.

The X-ray corroborates all these physical signs and will be of the greatest aid when the lesion is on the right side.

The lung shadow on the affected side will be more opaque and will suggest a purulent pleural effusion in its degree of density. The extent and density of this shadow will, of course, vary with the amount of lung involved and the degree of atelectasis. As the air returns this opacity gradually disappears, the opposite to a pleural effusion! Instead of an increased intrapleural pressure, as in pleural effusion, with a pushing away of the heart and diaphragm, there is a negative one and the heart and the diaphragm encroach or are pushed into the empty pleural space. The X-ray interpretation in one of our cases was subdiaphragmatic abscess.

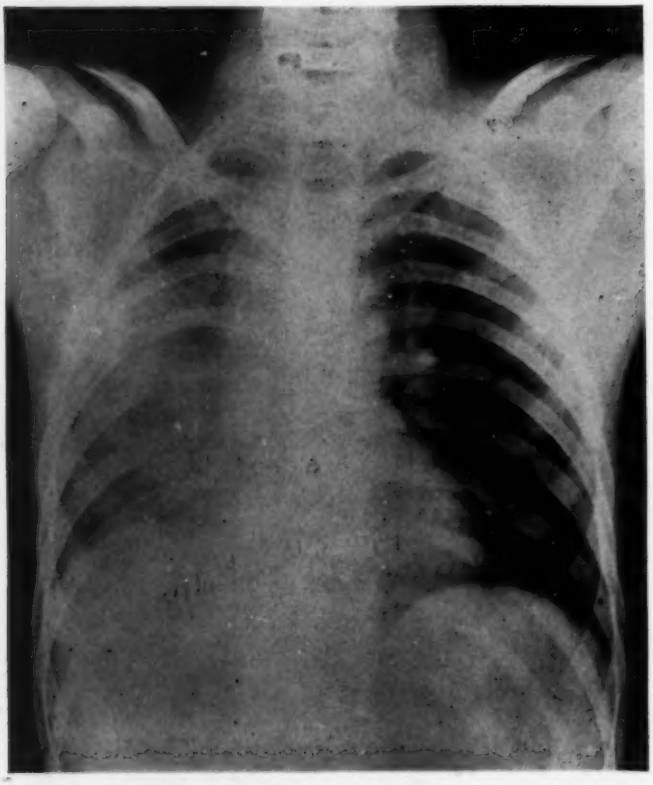


FIG. 4.—Charles L., patient of Drs. Walter Estell Lee, Gabriel Tucker, Harry Wilmer and Howard Geissler, Germantown Hospital. Picture taken two days after the onset of the massive pulmonary collapse of the middle and lower lobes of the right lung and on the fifth post-operative day. This picture was taken immediately after bronchoscopic drainage of the obstructing mucus from the bronchi of the right, middle and lower lobes. The middle lobe contains less air than the upper and lower lobes, both of which contain a larger amount than before the bronchoscopic drainage. The heart has also moved to the left and the level of the right diaphragm is almost normal. The trachea is in the midline. Radiograph by Dr. Henry T. Thissell.

Varieties.—The clinical varieties of massive collapse are quite similar, irrespective of their etiology. Thus the clinical forms may be (1) lobular, (2) lobar, or (3) total in distribution. In the lobular or partial type the upper or middle third of one or *more* lobes is the part most frequently affected. In the lobar type one or both lobes are usually affected. In the total variety the whole lung is in collapse.

Rose-Bradford [19] gave the first exhaustive discussion of this phenomenon which he encountered so frequently as a result of gunshot wounds of the chest. That it was not fully recognized by him until after very extensive experience with chest wounds probably means that it is much more frequent than he found. He reports his belief that it occurs in fully 10 per cent. of all non-penetrating injuries of the thoracic wall. He did not have the opportunity

of seeing patients who had wounds of other portions of the body, his work being confined to those of the chest, but as we have elsewhere stated he had knowledge of its occurrence following abdominal wounds, wounds of the pelvis, buttocks and lower extremities, but in no cases with wounds of the head or upper extremities.

The varieties encountered in thoracic wounds he divided into homolateral, contralateral and bilateral, all of which may be lobular, lobar or total. The contralateral variety of massive collapse involving the whole of one lobe of one lung is a very remarkable condition, more especially as in many cases the wound on the opposite side is not only non-penetrating but most trivial in character, causing no fracture or extensive injury to the chest wall. Personal communications from a number of American, English and French medical officers in the last war has given evidence that this phenomenon was frequently recognized but unexplained. In the war, of course, the determination of its earliest establishment after the receipt of the wound was quite impossible but Rose-Bradford reports that he had a recent case which was completely established with total massive collapse of one lobe fourteen hours after the receipt of the injury.

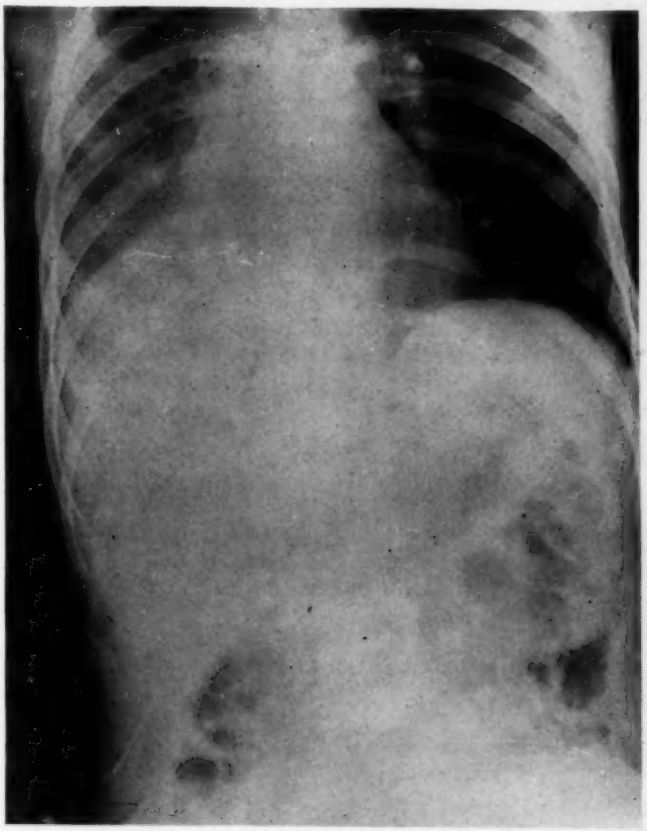


FIG. 5.—Charles L., patient of Drs. Walter Estell Lee, Gabriel Tucker Harry Wilmer and Howard Geissler, Germantown Hospital. Picture taken fifteen minutes after the taking of Fig. 4. Radiograph by Dr. Henry T. Thissell.

Incidence.—This phenomenon has been described as associated with many conditions since Pasteur's original report. Thus Norris and Landis speak of massive collapse of the lungs as a complication of pneumonia. Rose-Bradford [19] reports the autopsy of such a case. Tidy [21] reports an undoubted case of massive collapse of the entire right lung in a case of diaphragmatic pleurisy. Jorg,[49] in 1832, Legendre and Bailly,[49] in 1844, and Reynolds,[22] in

1871, described the airlessness in the lungs of newborn children and Reynolds called the condition apneumaptosis, or, as we now speak of it, atelectasis. He was convinced at this early date that the distribution of the affected lobules has a direct relation to the bronchial tubes, lobules supplied by one particular bronchial tube often presenting characteristic lesions, while lobules supplied by closely adjacent bronchial tubes were perfectly healthy. To his mind this precluded the possibility of an infection spreading by simple continuity. Literature contains the largest number of references to this phenomenon occurring after diphtheria, as originally described by Pasteur.[13] The military surgeons supply the next largest group in those following trauma, especially following unilateral wounds of the thoracic wall and occasionally wounds of the buttocks, pelvis and thigh. And, finally there is an increasing incidence in the surgical literature as its relation to operative procedures, especially upper abdominal, is becoming appreciated.

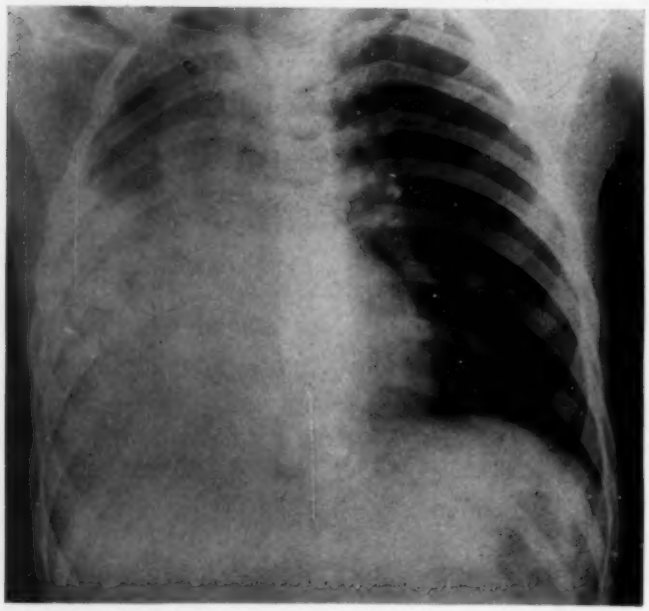


FIG. 6.—Charles L., patient of Drs. Walter Estell Lee, Gabriel Tucker, Harry Wilmer and Howard Geissler, Germantown Hospital. Picture taken twenty-four hours after the bronchoscopic drainage of the obstructing mucus in the bronchi of the right, middle and lower lobes and three days after the onset of the massive pulmonary collapse of these lobes. The re-accumulation of mucus again obstructs the bronchi and the collapse of these two lobes is almost as great as Fig. 1. Radiograph by Dr. Henry T. Thissell.

Thus this condition may develop as a congenital deformity (as in apneumaptosis in the newborn); it may develop spontaneously (as in diaphragmatic pleurisy); it may follow infection in the lungs or in the bronchi (as in pneumonia and purulent bronchitis); it may follow non-penetrating traumatisms of the chest wall and of the adjacent abdominal wall, buttocks and pelvis; Chevalier Jackson[50] has demonstrated its occurrence in cases of foreign bodies in the bronchi; and it has probably a greater incidence after abdominal procedures than the 8 per cent. reported by Pasteur. For such varied conditions it would seem difficult to find a common etiological factor and this is apparently true judging from the discussion of its etiology that appears in the recent literature.

Etiology.—Pasteur[13] in his study of post-diphtheritic phrenic paralysis quotes perhaps one of the earliest observations made by Martin and Hare, who found bilateral collapse of the lungs in animals dying after section of both phrenic nerves.

Briscoe [16] experimenting with normal rabbits, divided the phrenic nerve on one side of the neck and was able to obtain varying degrees and locations of pulmonary collapse following this procedure. Curiously the deflation was not limited to the same side as the paralyzed half of the diaphragm. The opposite lung was affected in almost the same area, and frequently to a greater extent. He was also unable to obtain any evidence of reflex paralysis or arrest of one-half of the diaphragm as the result of intra-abdominal irritation. Of course, as he says, these experiments were tried on normal animals and not ill ones, as the patients of Pasteur. He reports three observations on cases of spinal paralysis due to injury and paresis, in which there was a complete paralysis of the cord *high* up, and in these cases he found complete deflation of the pulmonary lobes.

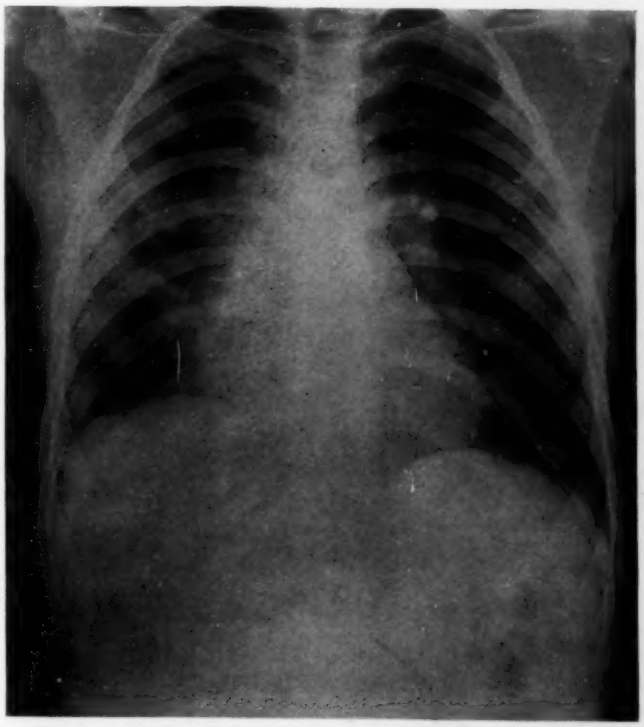


FIG. 7.—Charles L., patient of Drs. Walter Estell Lee, Gabriel Tucker, Harry Wilmer and Howard Geissler, Germantown Hospital. Picture taken two days after the first bronchoscopic drainage of the obstructing mucus and just before the second bronchoscopic drainage. This was three days after the onset of the symptoms of massive pulmonary collapse. In the preceding twenty-four hours there had been a copious expectoration of thick tenacious mucus similar to that removed through the bronchoscope. The air capacity of the lungs is now almost normal. The heart has returned to its normal position and the trachea is in the midline. Radiograph by Dr. Henry T. Thissell.

Schroeder and Green [34] state, as the result of clinical and experimental work with animals and birds, that the diaphragm is an essential muscle of respiration; that the nerve supply is practically dependent upon the phrenic nerve; that after section of the phrenic nerve the intercostal nerve supply is not sufficient to carry on the action of the diaphragm; that section of one phrenic nerve produces collapse of the lower lobe of the lung on the effected side. This, of course, is not in agreement with the work of Briscoe. The destruction of one phrenic nerve in man is not necessarily fatal.

Pearson Irvine [35] reports a case of diphtheritic paralysis of the thoracic muscles with an overaction of the diaphragm. In this case there was a definite collapse of the upper lobe of the lung. He is perhaps the first to suggest that this collapse of the lung is not only due to lack of movement of the thoracic cage, but to some extent to paralysis of the bronchial tree.

Lictheim [26] produced a definite collapse in the lung tributary to bronchi in which he had placed laminaria plugs. These experiments were performed with rabbits. This theory of bronchial obstruction is one which has appealed to many men and which, as before stated, has been clinically demonstrated over and over again by Chevalier Jackson in his experience with foreign bodies in the bronchi.

Elliott and Dingley [27] suggest that in man, consequent to immobilization of the thoracic wall and diaphragm, irrespective of its cause, secretion collects in the bronchioles, and even in the larger bronchi, sufficient to prevent the egress of air, and leads to a gradual absorption of the alveolar air by the pulmonary circulation and ultimate collapse and airlessness of the lung tissue. We have been able to confirm this by autopsies in two cases which are referred to elsewhere in this article.

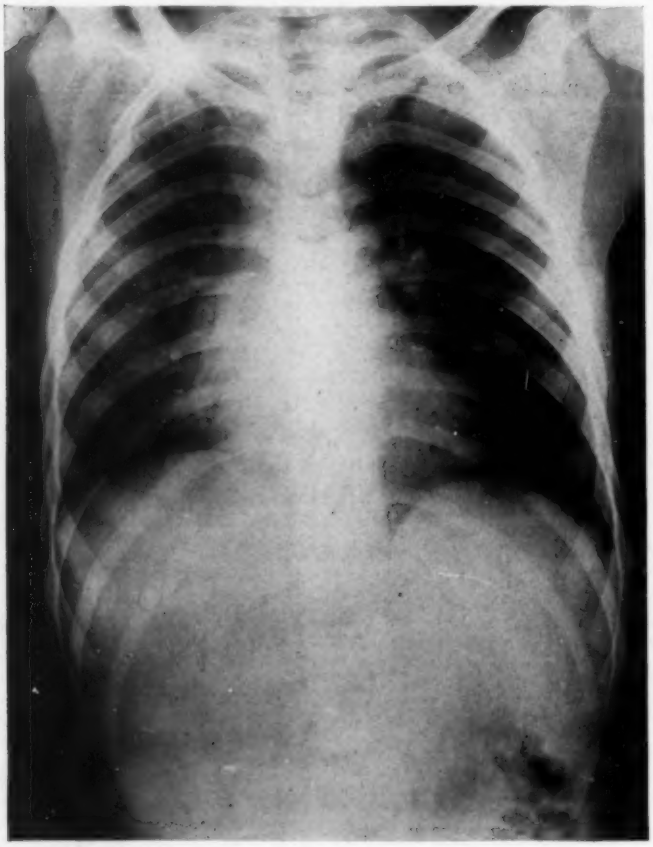


FIG. 8.—Charles L., patient of Drs. Walter Estell Lee, Gabriel Tucker, Harry Wilmer and Howard Geissler, Germantown Hospital. Picture taken four days after the first bronchoscopic drainage of the obstructing mucus and it shows almost complete restoration to the normal. This examination was made immediately before the second bronchoscopic examination by Doctor Tucker. Radiograph by Dr. Henry T. Thissell.

Grailey and Hewitt [22] suggest the curious explanation that the tapering funnel-like character of the bronchial tree would necessarily have an action on the obstructing plugs similar to that of a ball valve, the effect of inspiration being to propel the plug towards the alveolar tract and to jam it when it arrives at a bronchial tube whose calibre is less than the one it originally occupied. During expiration it would be dislodged, allowing the air to escape from the alveoli. Rose-Bradford [29] is inclined to feel that obstruction does not play an important rôle. He emphasizes the fact that it is well known insufficient expansion of the chest, however produced, is capable of causing collapse of varying degrees of the underlying lungs. In some instances a constrained posture or a prolonged recumbence is sufficient to cause extensive collapse, involving, for instance, one lobe of the lung. This has been clinically confirmed and referred to by Willy Meyer.

Briscoe [19] agrees in part with this statement, and after his experimental work with animals and analytical studies of the effect of posture on the respiratory movements of various individuals, says that massive collapse of the lower lobe of the lung is a natural sequence of prolonged quiet breathing in the supine position in such people as do not use the abdominal muscles to fix the chest. He suggests that it is circulatory in its actual beginning, and that as a result of inhibition of the respiratory muscles an œdema develops, following which collapse takes place.

Rose-Bradford [29] also finds that in some unexplainable way this condition is brought about by reflex action, particularly when it follows injury on the opposite side of the chest, upper abdomen and lower extremities. He confesses that Briscoe was absolutely unable to demonstrate this experimentally. Cymble [28] naively suggests that a man with a unilateral

chest wound would naturally lie upon the unwounded side, and the consequent immobilization of respiratory movement would be the real cause in the production of contralateral collapse.

Jackson [48] reports from his clinic their experience with bronchoscopy in post-tracheotomic pneumonias, in which the surprisingly low mortality of 1 per cent. is ascribed to their routine removal of obstructing bronchial secretions and diphtheritic membrane. He is convinced that the usual supposed pneumonia is an error of diagnosis. Over and over again they have seen the signs of pneumonia disappear in a few minutes after the removal of obstructing secretions from the bronchi. Many inspissated crusts of secretions were of sufficient size to obstruct completely a large bronchus. Jackson makes the definite statement that pneumonia is really one of the rarest complications following tracheotomy.

In this connection Jackson's recent experience with diphtheria in the Municipal Hospital in Philadelphia suggests that the post-diphtheritic collapse described by Pasteur, and believed by him to be caused by a paralysis of the respiratory muscles, is really due to bronchial obstruction of the passages by diphtheritic exudate. Certain it is that he and his assistants by the routine removal of these obstructing exudates in the bronchi have prevented this phenomenon of massive collapse in this clinic.

FIG. 9.—Charles L., patient of Drs. Walter Estell Lee, Gabriel Tucker, Harry Wilmer and Howard Geissler, Germantown Hospital. Picture taken one hour after Fig. 7 and immediately after second bronchoscopic examination by Doctor Tucker. There is a complete restoration to the normal of the pulmonary tissues and the position of the heart. This is four days after the bronchoscopic drainage of right lung. Radiograph by Dr. Henry T. Thissell.

A careful analysis of these apparently diverse conditions with which massive pulmonary collapse has been found associated shows two factors to be practically constant. First, obstruction of the bronchial tree, which is followed by the absorption by the pulmonary circulation of the air imprisoned in the alveolar spaces distal to the obstruction.

Second, some interference with the respiratory movements. This interference may be partial or complete, but always results in decreased aeration of the pulmonary tissue on the involved side.

Obstruction in the Bronchial Tree.—The effect of such obstruction was first demonstrated experimentally by Mendelsohn in 1845 [49] and later by Lictheim in 1878,[26] but the clinical work of Chevalier Jackson and his assistants in the removal of foreign bodies impacted in the bronchi has established

this phenomenon beyond the possibility of controversy. Jackson states that this obstructive atelectasis has been shown by Manges at the bronchoscopic clinic to be a most valuable means of diagnosis of non-opaque bodies in the bronchi.[54] The similarity of the clinical symptoms and the X-ray pictures before and after the removal of foreign bodies through the bronchoscope, to the findings in the massive collapse encountered in post-operative pulmonary complications has impressed us for some time. Jackson was the first to call attention to this and Leopold,[44] in his report speaks of Jackson's suggestion that possibly a bronchoscopic examination might not only determine the etiology of this condition, but also serve as a therapeutic procedure. We have previously reported a case,[43] our first clinical observation of post-operative massive pulmonary collapse, which followed an operation under local novocaine anæsthesia for a strangulated left femoral hernia. At autopsy Belk found a definite collapse of the lower right lobe of the lung with a purulent pneumonia of the upper two lobes. In tracing the bronchus of the lower lobe definite plugs of organized or agglutinated purulent mucus were found in the bronchus, which completely blocked the pulmonary tissues served by it.

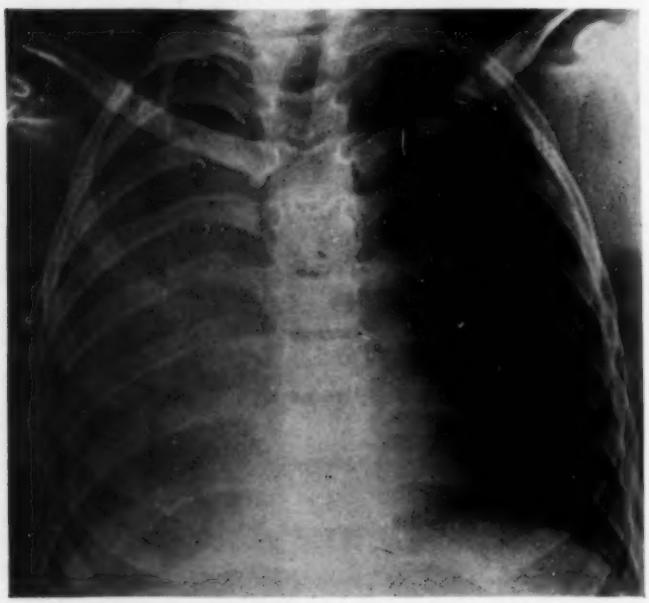


FIG. 10.—I. P., patient of Dr. Charles F. Mitchell, Pennsylvania Hospital. Picture taken five days after the removal of a gangrenous appendix and drainage of an abscess by Doctor Robbins and six hours after the onset of the clinical symptoms of acute massive pulmonary collapse. Massive collapse of the middle and lower lobes of the right lung. Partial displacement of the heart to the right of the spine. Displacement of the trachea to the right. Radiograph by Dr. David R. Bowen.

To quote the record of Doctor Belk: "The autopsy showed briefly an anomalous right lung with only two lobes. The upper lobe was the seat of a lobar pneumonia. Near the root of the lung was a definite abscess, about 3 cm. in diameter, filled with a heavy, sticky, purulent material. This abscess was in direct connection with the bronchus to the lower lobe, which is completely occluded. This lobe was partially collapsed, leaving a space about 8 x 8 x 12 cm. between itself and the upper lobe. Dense adhesions to the diaphragm had apparently prevented the lower part of the lobe from contracting upward. In addition to the collapse there were small areas of lobular consolidation present. Crepitation was barely appreciable. From a pathological standpoint the case is undoubtedly an example of partial pulmonary collapse resulting from occlusion of a bronchus." (See Fig. 1.)

We again refer to this report because in a recent bronchoscopic examination made by Tucker similar plugs of mucus were found in the bronchi of a case in which acute massive collapse of the lung had occurred post-operatively. The removal of these plugs through the bronchoscope allowed the distal pulmonary tissue to re-expand with air as was shown by the X-ray taken by Doctor Thissell and the clinical examination made by Doctor Geissler and Doctor Wilmer. When the clinical and X-ray examinations showed a return to normal of the previously collapsed lung, a bronchoscopic examination demonstrated the disappearance of the mucous plugs that had been previously found.

FIG. 11.—I. P., patient of Dr. Charles F. Mitchell, Pennsylvania Hospital. Picture taken four days after the onset of the clinical symptoms of massive pulmonary collapse. A small amount of air in the right upper lobe. Middle and lower lobes incomplete collapse. Heart displaced to the right of the spine. Trachea displaced to the right. Radiograph by Dr. David R. Bowen.

Following are the notes of this case prepared by Doctor Stiles, resident surgeon of the Germantown Hospital, in which this patient was operated upon.

"The patient, Charles L., a normal boy of twelve years. He was in the best of health until the time of the onset of his present illness. On January 6, 1925, he was seized with an attack of generalized abdominal pain, which later settled in his right iliac fossa. Three days later the family physician called Doctor Wilmer in consultation, who sent him to the hospital. About an hour after admission to the surgical service of Doctor Lee, his abdomen was opened by Doctor Davis, with a muscle-splitting incision in the right iliac fossa, and this incision opened directly into a well walled-off collection of pus. The appendix could not be readily isolated, and a cigarette gauze drain was introduced into the wound. For 48 hours the patient was very comfortable, his temperature ranging around 99, his pulse around 100 and his respiration 28. Perhaps the most significant point in this portion of his history is that he was kept lying on his right side almost continuously in order to facilitate drainage.

About two o'clock in the morning of the third post-operative day the patient was awakened by a short but severe attack of coughing, after which he went back to sleep. At five o'clock his temperature had climbed to 101.3 his pulse to 120 and his respiration to 32. At 7.30 he complained that any effort to talk gave him great discomfort, and that he had a choking feeling in his throat. Physical examination at this time showed nothing

save distant breath sounds over the bases of both lungs posteriorly. There were no areas of dulness demonstrable. At noon the patient seemed more ill. His pulse had jumped to 140 and his respiration to 52. His temperature remained practically constant. He looked hard hit. His right chest scarcely seemed to expand with inspiration. On percussion impairment was found at the apex, dulness between the second and fourth ribs and a high tympanitic note below the fourth rib. Posteriorly the percussion note was almost flat. The note over the entire left chest was distinctly hyperresonant. Breath sounds were tubular throughout the right lung. At the base the sounds were somewhat distant. The area of superficial cardiac dulness had moved markedly to the right. At the the level of the fifth rib it extended but 3 cm. to the left of the midline and fully 6 cm. to the right. The heart sounds were heard better over the right side of the chest than over the left. They were very distinct in the right axilla.

FIG. 12.—I. P., patient of Dr. Charles F. Mitchell, Pennsylvania Hospital. Picture taken seven days after the onset of massive pulmonary collapse. Since previous picture, Fig. 11, there has been a slight increase in the amount of air in the right upper lobe, the heart has moved slightly to the left. The trachea is still displaced to the right and the intercostal spaces on the right side are narrower than on the left. Radiograph by Dr. David R. Bowen.

Doctor Lee saw the patient at the time and diagnosed the condition as one of pulmonary collapse, and ordered immediate X-ray examination. (Fig. 2.) The X-ray showed a collapse of the middle and lower lobes of the right lung, with the heart displaced well over to the right.

The following day (fourth post-operative) the patient was much more comfortable. His temperature had fallen to 100, his pulse to 124, and his respiration to 36. He was coughing occasionally, bringing up a thick, grayish or greenish sputum. The right chest was retracted and almost motionless. The percussion note below the fourth rib was no longer tympanitic, but was flat. Distant tubular breathing could be heard in this area. Posteriorly the breath sounds were tubular, but were not quite so distant. The X-ray showed the same picture as before. The second day after the onset of the collapse (and the fifth post-operative) the patient's condition was practically unchanged. He was still quite dyspnœic. He could not say more than three or four consecutive words without having to catch his breath. Physical examination showed almost no change. The X-ray demonstrated somewhat more air in the lung than previously. (Fig. 3.) Late in the afternoon of the second day Doctor Tucker performed a bronchoscopy. He found marked inflammatory reaction in the bronchi of the right lung, which contained a tenacious mucus entirely closing up some of the air passages. As much as possible of this mucus was removed. Physical examination immediately afterwards showed a fairly resonant

percussion note over the right chest above the fifth rib. Breath sounds seemed to be about normal save for some prolongation of expiration. Vocal resonance seemed practically normal. The area of superficial cardiac dulness had moved about 2 cm. to the left, and an immediate X-ray examination showed much more air in the lung. (Fig. 4 and Fig. 5.) An hour and a half later the patient was sleeping quietly and his respiratory rate was 22. An hour after this, however, his respirations had increased to 30. The percussion note over his right chest anteriorly was again tympanitic. On auscultation the breath sounds were much fainter.

FIG. 13.—I. P., patient of Dr. Charles F. Mitchell, Pennsylvania Hospital. Picture taken ten days after the onset of massive pulmonary collapse. A marked increase in the amount of air in the right upper and middle lobes. Displacement of the trachea and the heart to the right, less marked than in previous picture, Fig. 12. Radiograph by Dr. David R. Bowen.

The report of the bronchoscopic examination by Dr. Gabriel Tucker and Doctors Clerf and Williams is as follows: "The larynx was only slightly inflamed. The tracheal mucosa was reddened and a thick, glary, grayish secretion was adherent to the tracheal walls. The inflammatory condition was more intense as the trachea was followed downward to the carina. The mucosa of the right bronchus was very red and inflamed. There was a ring of thick tenacious mucus completely surrounding the lumen of the right main bronchus. The left bronchus was only slightly inflamed and seemed to be entirely clear of secretion. The thick secretion was removed by aspiration and the lower bronchial divisions in the right lung were explored. The mucosa in all the bronchi was very reddened and thickened, and covered with a thick, tenacious secretion. The orifice of the upper right lobe bronchus was not completely blocked, but patches of secretion were adherent to the walls surrounding it. Secretion was abundant in the middle lobe bronchus, but there seemed to be an airway. The lower lobe bronchus seemed completely filled with a tenacious exudate. The exudate was aspirated from the upper lobe, the middle lobe and the main division of the right lower lobe bronchus. A swab specimen of the secretion was taken for culture. Deviation of the right main bronchus towards the right was noticed, but there was no evidence of bronchial compression. There seemed marked restriction of the bronchial movements. The inspiratory lengthening and opening of the bronchus was very slight, particularly in the lower and middle lobe bronchi.

Bronchoscopic Diagnosis—Diffuse bronchitis involving the right main bronchus and branches, most marked in the stem, lower lobe and middle lobe bronchi. Bronchial obstruction of the middle and lower lobes due to masses of thick, taut, adherent, tenacious

secretion. The culture obtained from these secretions showed staphylococcus aureus and pneumococci.

The following two days (seventh and eighth post-operative) showed a slow improvement. Resonance on percussion gradually extended down the anterior chest wall, the heart moved slowly over towards the left, and the breath sounds began to approach normal. X-ray examination showed an increase in the aeration of the lungs. During this period the patient brought up considerable quantities of grayish sputum similar to that removed through the bronchoscope. Râles were heard frequently over the right chest, especially over the lower lobe. (Fig. 6.)

FIG. 14.—I. P., patient of Dr. Charles F. Mitchell, Pennsylvania Hospital. Picture taken thirteen days after the onset of massive pulmonary collapse. Upper and middle lobes reinflated with air to almost normal capacity. Lower lobe still in collapse. Trachea now in midline. No change of position of heart since last picture, Fig. 13, which was taken on tenth day. Radiograph by Dr. David R. Bowen.

The fourth day following the first bronchoscopy (the ninth post-operative) showed a marked improvement. The right chest seemed fuller. It was moving quite freely in respiration. There was resonance to percussion as far down as the sixth rib anteriorly. The area of superficial cardiac dulness extended twice as far on the left as on the right. Breath sounds were approximating the normal. The upper and middle lobes seemed to be functioning completely and the lower lobe partially. An X-ray examination at 3 P.M. showed much more air in the lungs than before. (Fig. 7.)

At 3.40 the patient was again bronchoscoped (ninth post-operative day). The report of this examination, which was made by Doctor Tucker, assisted by Doctor Clerf, Dr. Ernest Raffe and Dr. Horace J. Williams, is as follows:

The inflammatory condition of the tracheo-bronchial mucosa was less severe than at the previous bronchoscopy. A small amount of mucoid secretion, slightly purulent in character, was found in the trachea coming up from the right main bronchus. The mucosa of the left main bronchus was less inflamed, no secretion was present. The right bronchus showed marked deviation, and the bronchial movements were much more nearly normal than at the last observation. On inspiration the bronchus seemed to lengthen and open about the normal excursion. Very little secretion was present in the upper right lobe bronchus. The middle lobe bronchus contained more secretion, but was thin and quite easily aspirated. The lower lobe bronchus showed more marked inflammatory thickening, and the secretion was thicker and was aspirated with much more difficulty. Swab cultures were taken from the right main bronchus. All of the lower lobe bronchi were aspirated free of secretion. The culture from this swab showed staphylococcus aureus.

Doctor Tucker summarizes his findings, and says that they indicate that there is a much greater degree of aeration in the right lower and middle lobes than at the time of the last bronchoscopy.

Subsequent to this examination the physical findings showed practically a normal area of resonance over the right lung to percussion, both anteriorly and posteriorly. The heart seemed to be in normal position, the breath sounds were normal, save for some roughening. The vocal resonance seemed normal throughout. This was all confirmed by an X-ray picture taken immediately after bronchoscopy. (Fig. 8.) The following morning the patient was very comfortable. Pulse, respiration and temperature were all normal. The right chest seemed to be moving practically as freely as the left. Percussion gave normal resonance throughout save for a slight impairment in the right lower lobe. Breath sounds were not quite so distinct over this area as over the rest of the lung. Vocal resonance was normal throughout. Many râles were heard over the lower lobe.

FIG. 15.—I. T., patient of Dr. Charles F. Mitchell, Pennsylvania Hospital. Picture taken twenty-four days after the onset of massive pulmonary collapse. Upper and middle lobes are almost completely reinflated while the lower lobe is not entirely normal. The heart has moved further to the left but has not quite reached its normal position. Radiograph by Dr. David R. Bowen.

In contrast to this very prompt operative relief of the bronchial obstruction and the restoration of the alveolar tissue to the normal within 48 hours is the following history of a case where spontaneous relief was not complete until the lapse of over six weeks:

A poorly nourished Jewish boy of fourteen years of age was admitted to the service of Doctor Mitchell at the Pennsylvania Hospital, October 16, 1924, with a diagnosis of appendiceal abscess with probable generalized peritonitis. He was operated upon by Doctor Robbins within one hour after his admission under nitrous oxide, oxygen anæsthesia. A gangrenous perforated appendix was removed and a localized abscess drained with one cigarette drain which reached into the pelvic cavity. He made a rather remarkable recovery from the operation until the fifth day, when at 6 A.M. he had a severe spell of coughing. As he had had a definite bronchitis before his operation and his lungs had been wet and there had been profuse thick greenish expectoration during these five days, no particular attention was paid to this at first. Following the spell of coughing his

temperature rose promptly to 105 degrees, his pulse to 152 and his respiration to 52. With the onset of the coughing there was definite cyanosis. He was seen by Doctor Lee four hours later, and a diagnosis of massive collapse of the lower lobe of the right lung was made.

Doctor Edgar's notes of a physical examination at this time were to the effect that the right side of the chest was sunken, the intercostal spaces retracted, and there seemed to be no expansion on the right side of the chest. He complains of pain through the affected side. The heart is definitely moved over to the right side, and the right border is 5 cm. to the right of the right edge of the sternum. There is a considerable area of dulness anteriorly and posteriorly which involves the upper and probably most of the middle lobe. Heavy percussion, however, gives a tympanitic quality to this note. Local fremitus is increased over the right upper lobe, but it is absent over the lower right chest. The breath sounds are loud, amphoric over the entire right chest, and diminish in intensity as one goes down towards the axilla and towards the posterior aspect. Voice sounds and whispering pectoriloquy are very pronounced and close to the ear. There are no crackling râles heard anywhere, although a few scattered bronchi or bronchial mucous râles are heard in both lungs.

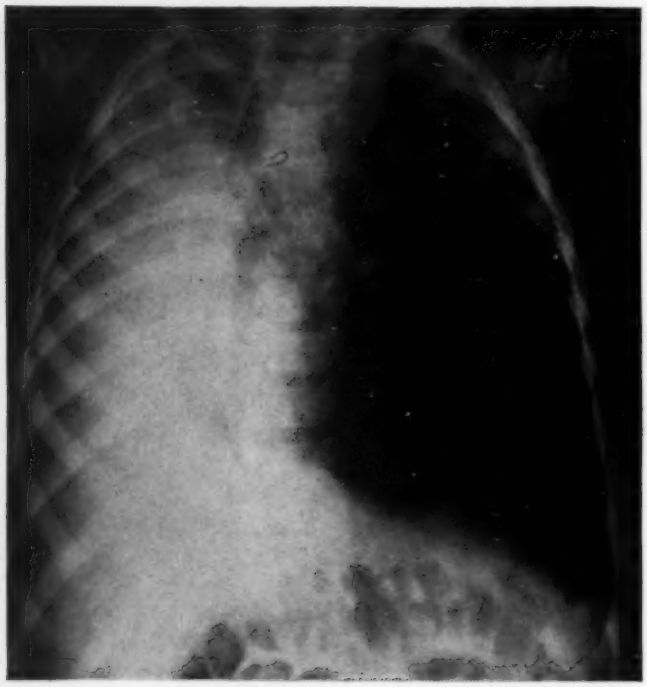


FIG. 16.—J. G., patient of Dr. Chevalier Jackson. Right main bronchus is obstructed by a bean. There is massive collapse of the upper, middle and lower lobes of the right lung. Complete displacement of the heart to the right of the spine.

The precordial heave is pronounced over the lower right chest extending to the right nipple line. Sounds are loud, rapid, but no murmurs are heard. Dr. Thomas McCrae saw the patient this day and concurred in these signs, and with the diagnosis of massive collapse of the lung. Dr. Arthur Newlin also saw the patient at this time, and his notes include comments on the cyanosis of the lips and fingers with moderate dyspnœa. He also notes the displacement of the heart. "The whole right side is flat anteriorly. Breath sounds are faint below the third interspace anteriorly. The vocal resonance is increased, and there is dry amphoric breathing." The cough gradually became more productive and the expectoration of a thick green-yellow material, which was noted before this catastrophe, has increased in quantity and freedom of expectoration. Almost daily X-ray pictures were taken, which show the slow return of air to the collapsed portion of the middle and lower lobes and the gradual moving of the heart shadow to its normal position in the mediastinum and left thorax. On November 27, 1924, the X-ray shows that there is complete restoration to normal of the right lung and of the heart in its normal position in the thoracic cavity. A period of 42 days.

We have also had the unusual opportunity of observing an autopsy by Doctor Hoge

at the Pennsylvania Hospital of an 18-year-old negress who died three days after a Cæsarean section performed by Doctor Piper at the Lying-in Hospital of Philadelphia. Three days after the Cæsarean section she developed an acute catastrophe which was first diagnosed as pneumonia in the left chest.

She was seen by Doctor Wolferth in consultation, and he noted a marked diminution of expansion all over the left lung. No marked alterations in percussion anteriorly and posteriorly appeared at the examination. Anteriorly and posteriorly there was typical bronchial breathing over both upper and lower lobes. On the right side the breathing is exaggerated and there are moist râles, particularly at the bases. The heart position is decidedly to the left, and apparently the mediastinal structures are deviated to the left.

"The last feature suggests the possibility of massive collapse of the lung, although at present the most likely diagnosis is post-operative pneumonia."

Doctor Wolferth did not feel certain of this diagnosis of massive collapse, and the patient died six hours after his examination.

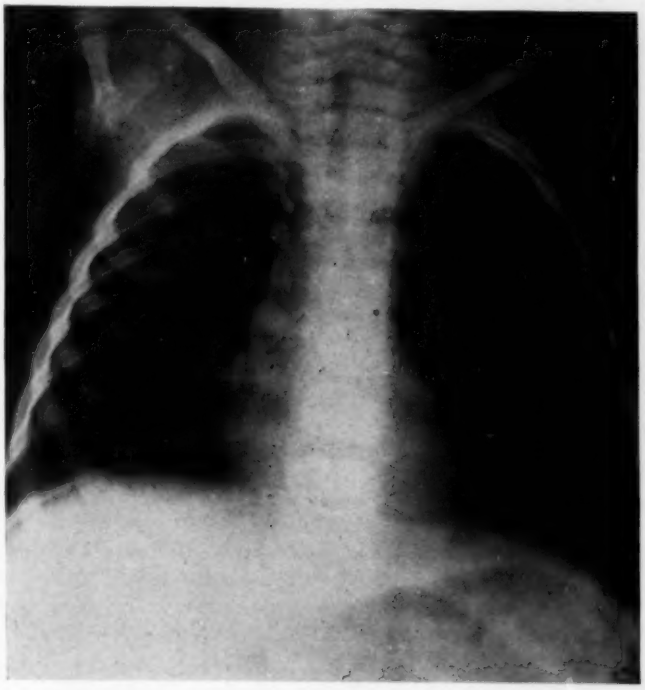


FIG. 17.—J. G., patient of Dr. Chevalier Jackson. Picture was taken of the same patient as in Fig. 16, but twenty-four hours after the removal through a bronchoscope of the obstructing bean from the right lung and the heart and trachea have returned to their normal positions.

An autopsy was performed at the Ayer Laboratory of the Pennsylvania Hospital before rigor mortis had set in.

Anatomical Diagnosis: Primary Fatal Lesion.—Post-operative collapse of the left lower lobe of the lung.

Secondary or Terminal Lesions.—Recent pregnancy, recent operation, Cæsarean section, moderate localized peritonitis and paralytic ileus, complete atelectasis of the left lower lobe of the lung with purulent bronchitis and partial atelectasis of the base of the right lobe, mild bilateral hydro-ureter and hydronephrosis.

Peritoneal Cavity.—The usual post-operative findings existed that one sees after an uncomplicated Cæsarean section. The uterine wound was healed, no leakage was present, and the incision was covered by a plastic exudate. The intestines were moderately distended. The liver appeared to be well above the costal margin. The right dome of the diaphragm occupied an unusually high position, reaching to the third rib, while the left dome is at the level of the fifth rib.

Thoracic Cavity.—On opening the chest cavity one is immediately struck by the extremely limited size of the chest. A high position of the diaphragm (probably the result of the recent pregnancy) has reduced markedly the size of both cavities. The position of the heart when measured *in situ* shows the right side to be 5 cm. from the midline, and the left 8 cm. Both lungs appear small. There is no free fluid.

Heart.—The heart weighs 220 grams. It is normal in appearance and size, and the valves and chambers show no change.

Lungs.—The lungs are removed with the trachea intact. Both upper lobes although small, appear moderately crepitant and air-containing. The lower lobes present an interesting picture. The right lobe is purplish in color with many dark patches. A close inspection reveals groups of pulmonary lobules which are definitely air-containing. The lower lobe on the left is extremely dark, quite limp and absolutely non-air-containing. The inferior edge all around presents a distinct lip of collapsed pulmonary tissue. On section of the left lung the lower lobe is found to be almost pitch black, presenting the picture of complete atelectasis. Compression of this pulmonary tissue causes the exclusion of thick mucopurulent pus from the bronchioles. Dissection of the bronchial tree reveals extremely tenacious purulent mucous, filling the entire bronchi leading to the lower lobe. It is extremely sticky in character. On section of the lower lobe, right side, the picture seen is that of a partial atelectasis. The presence of pus in the bronchioles is not demonstrable here. Both upper lobes, although small, appear essentially normal.

Diaphragm.—The appearance of the diaphragm is interesting, especially on account of its relation to the pulmonary condition. There is a moderate injection of the vessels of the peritoneal surface, particularly about the coronary ligaments. This same type of injection is present in the thoracic surface, especially on the left side. There is exudate on this surface.

Microscopical Examination of the Lungs.—(Four sections in all) No. 2988, 1925. All show the same picture, varying in degree to some extent. There is diffuse atelectasis which is practically complete in all the sections studied, so that in many areas not the slightest vestige of an alveolar space remains, the tissues being composed of closely packed alveolar walls. One of the most noticeable features is the marked dilatation of the alveolar capillaries with all of the smaller vessels of the lungs appearing to be universally congested with distended red blood cells to several times their normal width. All of the bronchioles contain exudate, which is rich in fibrin, in the meshes of which are closely packed polymorphonuclear leucocytes and small mononuclear leucocytes, generally completely plugging the bronchiolar lumen. Interestingly enough the bronchial walls and the peribronchial spaces do not show evidences of surrounding infection comparable to the usual picture of bronchiolar pneumonia. Associated with the terminal bronchi, however, the evidence of infection and exudate definitely spread out through the striæ and neighboring alveoli, causing small areas of bronchial pneumonia. *Diagnosis.*—Bronchitis (Bronchiolar pneumonia with atelectasis of the lower lobes of both lungs).

Complications.—If inflammation supervenes, râles may appear and a friction sound be heard over the accompanying pleuritis. Expectoration rarely appears until pneumonitis is established and it is seldom bloody until this stage is reached. Its presence is inferred largely by an increase in the severity of the symptoms rather than by any other sign. Purulent bronchitis undoubtedly occurs as a complication as is evidenced in our case. Pleurisy is not uncommon at a late complication. It is usually the dry variety giving rise to a friction rub but effusion may occur later.

Differential Diagnosis.—The differential diagnosis must be made from acute dilatation of the heart, pulmonary embolus, pulmonary infarct, pleuritis, with or without effusion, pneumothorax and diaphragmatic hernia.

If one bears in mind that the affected side is retracted and immobile; that the diaphragmatic and cardiac encroachment on the affected side is extreme; that the general symptoms are invariably less severe than with pneumonia, embolism and infarction; that marked hyperresonance and increase of breath sounds with loud transmitted voice sounds are present, the diagnosis should

be made. To this is added the high level of the diaphragm and the question of the displaced impulse. Pneumothorax is a very common mistaken diagnosis. Cardiac dilatation has been an explanation of the misplaced cardiac area. This is especially true when the collapse is of the left lung. The fact that even in cases of marked cardiac displacement the pulmonary physical signs may be comparatively slight, often gives rise to a mistaken diagnosis, such as dextrocardia, but after a lapse of a few hours or days there is usually a development of the pulmonary signs and the diagnosis is made conclusive by the return of the heart to its normal position.

The upward displacement of the diaphragm is a sign of the greatest importance and is detected on the left side by physical examination and on the right side by X-ray. It should also be remembered that when the entire lung and upper lobe or lobes are collapsed, the displacement of the cardiac impulse is oblique. In the first period the signs are those of retraction and immobility of the affected side, together with weakness or absence of breath sounds and displacement of the heart which is often extreme. In the second period weakness of the breath sounds has been replaced by loud tubular or amphoric breathing together with increased vocal fremitus, loud bronchophony, pectoriloquy and transmitted spoken voice. In the third period, the stage when the lung is expanding, abundant râles may be present over the area where the tubular breathing is marked. In both the second and third periods the heart is still displaced, but as we previously mentioned, the lung signs may sometimes persist over a small area at a time when the heart has returned to its normal position.

Prognosis and Mortality.—It is impossible to estimate the mortality at the present time because of the general lack of recognition of the condition. We believe that we have had five cases during the last two years and have obtained an autopsy in two cases. Our purpose in presenting this subject before such a body is to obtain, if possible, the real incidence of post-operative massive pulmonary collapse. We are convinced that it is far greater than Pasteur's 8 per cent. which he reported in 1914.[16]

To us this evidence, consisting of two post-mortem findings and one bronchoscopic examination *in vivo,* would seem conclusive evidence that obstruction of the bronchi by mucus plugs may produce varying degrees of pulmonary collapse, according to the character of the foreign body and the completeness of the obstruction of the bronchi produced by the mucus plugs. Manges, from his experience with foreign bodies, states that atelectasis or collapse does not occur until such times as the obstruction is complete to inspiration. If the obstruction is incomplete then instead of atelectasis you have the tissues beyond the obstruction overdistended with air. This may be the explanation of the two distinct clinical groups into which post-operative massive collapse may be divided. In one, over the area occupied by the collapsed lung, there is hyperresonance and even tympany, the vocal fremitus is increased and the breath sounds are loudly tubular or amphoric while bronchophony and pectoriloquy are well marked. Here we

may have incomplete obstruction to inspiration. The clinical symptoms in the second groups are exactly the opposite, vocal fremitus is diminished and the breath sounds are absent over this area and the atelectasis is complete as we would expect in a sudden and complete obstruction of the bronchi.

The other factor common to conditions in which acute massive collapse of the lung is associated is partial or complete arrest of the respiratory movements. Thus, in pleurisy, pneumonia, diphtheritic paralysis of the diaphragm, or the voluntary and reflex inhibition of the diaphragm and abdominal muscles in upper abdominal operations, this mechanism is obvious. Just as important and more constant is embarrassment of respiratory movements resulting from unnatural and prolonged rest after abdominal operations and other operative procedures and accidental injuries. Tidy explains the contralateral collapse associated with non-penetrating wounds of the opposite chest wall, which was found so frequently during the war by the patient lying upon the well side and thus immobilizing its respiratory movements.

Decreased aeration probably results in an increase in the bulk of the bronchial secretions because of decreased evaporation. These secretions gradually increase and accumulate in the large bronchi and when a point is reached where the tidal air is insufficient to maintain an airway, and the cough reflex fails to expel the mucus, the lumen will become completely obstructed. When this does result we have the mucus obstruction acting exactly as a foreign body. Jackson [51-52] in several recent contributions has called attention to the normal function of the cough reflex, As he expresses it: "The cough reflex is the watch-dog of the lungs." In view of this function we ask you to consider the effect of posture, severe post-operative abdominal pain and the generous pre- and post-operative use of morphin upon the expulsive cough necessary to clear the bronchial tree of secretion.

All this was clearly suggested by Elliott and Dingley [27] in 1914. Our present contribution consists in (1) having found a post-mortem in two cases such collections of mucus in the bronchi as to cause complete obstruction; (2) in having seen such obstructing masses of mucus *in vivo;* and that one of us (Tucker) removed these mucous masses or plugs through a bronchoscope and proved that after such removal the lung returned to its normal condition; (3) in recalling the suggestion of Briscoe,[18] Elliott and Dingley [27] and Elwyn that embarrassment of respiratory movement of the chest walls or the diaphragm is a predisposing factor, not only in the formation of the mucous plugs in the bronchi, but in the inability to expel them; (4) submitting evidence that this has been entirely confirmed by our clinical experience; (5) in stating that this phenomenon has definite surgical significance. To us its importance as a post-operative complication lies not in the occasional massive collapse that is to be encountered, but in the probable partial collapse of varying degree occurring after operative procedures, particularly in the upper abdomen, and traumatism of the trunk; (6) in suggesting that the arrest in these collapsed areas of the small emboli

which are usually scattered by the circulation after all operative procedures in which the blood-vessels are opened, as has been proven by Cutler,[1-2-57] is an explanation of the mechanism of post-operative pneumonia. (Lee.[43]) The clinical picture of the so-called cases of post-anæsthetic pneumonia is so unlike the true lobar and lobular pneumonias which are seen by the internist and physician that it is strange we have so complacently accepted this diagnosis up to the present time.

Conclusions.—Acute massive collapse or massive atelectasis is a phenomenon which has been recognized in association with varied conditions. Although diverse they have two factors in common which we believe have some bearing upon the etiology of pulmonary collapse, namely, embarrassment or paralysis of the respiratory movement and obstruction of the bronchial tubes. The interference with the respiratory movements may be as slight as that resulting from posture and may increase to that of the voluntary or reflex inhibition from post-operative pain of abdominal operations, or even reach the complete paralysis which occurs in diphtheria. Obstruction has been found to be caused by foreign bodies, bronchial secretion or extra bronchial pressure as is produced by tumors.

Massive collapse of the lungs is a comparatively rare condition and its incidence post-operatively is approximately greater than 8 per cent. However, it has a definite surgical significance which should not be overlooked. The most characteristic sign is displacement of the heart towards the collapsed lung.

Partial collapse of the lung is probably a very frequent complication following abdominal and particularly upper abdominal, operative procedures. The arrest, in these areas of partial collapse, of multiple emboli coming from the operative field is probably the mechanism and the lesion which so frequently occurs after operative procedures, and which is commonly called post-operative or post-anæsthetic pneumonia.

When infection is added to these minute multiple infarctions in the collapsed areas a true bronchial pneumonia is established. This we believe is rare compared to the frequency of partial collapse combined with minute pulmonary emboli and infarction.

If two of the factors underlying pulmonary collapse, either massive or partial, are (1) inhibition or arrest of respiratory movements and (2) subsequent obstruction of the bronchi with accumulated bronchial secretion, there are definite indications for prophylaxis and treatment of this condition. The minimizing of the trauma of all operative procedures, the conservative use of morphia and other inhibitors of the normal bechic or cough reflex; and the avoidance of fixed or unnatural positions post-operatively would seem rational procedures. The choice of such anæsthetic agents as have the least irritating effect upon the bronchi and result in the minimum bronchial secretions, as local anæsthesia, gas oxygen anæsthesia and ethylene, are mandatory. All these measures are prophylactic. After the condition of massive collapse is estab-

lished the dangers are not in the lesion itself, unless it be bilateral, but in the complications which are apt to ensue, as pneumonia in one of our cases, empyema and lung abscess. The fact that of the recorded cases that have recovered spontaneously the average duration of the recovery has been about twenty-one days and that in the case here reported seventy-two hours after removal of the obstructing bronchial secretion the lung had been restored to its normal condition, is at least suggestive.

Pulmonary Collapse Due to Foreign Body in the Bronchi, by DR. CHEVALIER JACKSON. Doctor Lee has shown, and, with the aid of the bronchoscopist, Dr. Gabriel Tucker, has proven, that, in at least some cases of post-operative massive collapse the condition is one of obstructive atelectasis. Doctor Lee and other members of this Association have asked me to say a few words on this form of pulmonary collapse, which we are using almost daily as a diagnostic sign of non-opaque foreign body or of plugs of secretion that are essentially foreign bodies. We have seen at the Bronchoscopic Clinic, hundreds of cases with atelectasis affecting one or more lobes and often an entire lung. These cases have nearly all been due to bronchial obstruction; but all bronchial obstructions do not produce atelectasis. Some of them produce exactly the opposite condition of emphysema.

We have three types of bronchial obstruction, namely: 1. By-pass-valve obstruction. 2. Check-valve obstruction. 3. Stop-valve obstruction.

I venture to predict that if you were to have every etherized patient examined immediately after operation with the Röntgen-ray, using the certain special technic that we use at the Clinic for this work, you would find all three types of obstruction. The technic consists of exposing the film at the extreme end of expiration and at full inspiration. As shown by Manges, the usual exposure at the command "Take a full breath and hold it," will be often misleading. At fluoroscopy the phenomena are still more marked to the trained eye of the röntgenologist. The corresponding physical signs may be elicited by the trained physical diagnostician, provided his examinations are made with the phases of the respiratory cycle in mind. Doctor McCrae has many times made the diagnosis by signs alone, prior to the ray examination. In the ordinary routine physical examination the phenomena will be entirely overlooked.

By-pass-valve obstruction is the type of partial obstruction that permits both ingress and egress of air past the obstruction.

Check-valve obstruction allows the air to pass in but not to emerge. This produces obstructive emphysema. Of this we have seen hundreds of cases. It was first observed, in a case of peanut kernel in the main bronchus, by Iglauer. We have seen it in hundreds of cases, not only of all kinds of nut kernels, in which it is diagnostic, but also in cases of swollen bronchial mucosa and in cases of plugs of tough secretion. My friend and pupil, the late Doctor Lynah, saw it many times also in cases of plugs of diphtheritic membrane. The usual mechanism of check-valve obstruction is the normal

enlargement of the diameter of the bronchial lumen during inspiration which opens a space for passage of air around the obstructive mass; this space being promptly obliterated by the normal expiratory diminution of the bronchial diameter. The pathologic factor is supplied not only by the bulk of the plug of mucus or other foreign body, but by the swollen mucosa of the bronchial wall which makes a soft cushion-like valve seat. The reverse of this check-valve obstruction in which air can get out but not in, is rare, because the lumen of the bronchi diminishes during expiration. Check-valve obstruction is due not so often to movement of the foreign body as to the normal expansion and contraction of the bronchial wall with inspiration and expiration, respectively.

Stop-valve obstruction is the type in which air cannot get either in or out. The residual air is absorbed and the tributary lung deflates; in other words, it collapses, and we have atelectasis. It is due to the keen original observation of Pasteur that we have been made aware of this condition as a post-operative pulmonary collapse. We have seen the same state of massive collapse frequently from plugs of secretion which we have removed. In one case my associate, Dr. Louis H. Clerf, bronchoscopically removed seventeen plugs of tough secretion, during four days, in a child aged three years. Each of the seventeen times death was imminent from collapse of both lungs due to plugging of both main bronchi. Beans and grains of maize often cause atelectasis or massive collapse of one lung because both the foreign body and the mucosa swell. Nut kernels do not swell, but the mucosa does, and after a preliminary stage of obstructive atelectasis from check-valve obstruction, we have obstructive atelectasis, if the nut kernel be not removed.

In a number of cases the foreign body has shifted, causing an atelectasis in different lobes, not simultaneously, but in succession. It has been very interesting to have Doctor Manges tell us in a case of shifting foreign body "How the prune stone is causing obstructive atelectasis of the lower lobe," the next day, "Now it is causing obstructive atelectasis of the upper lobe." Later, "Now it is causing obstructive emphysema of the upper lobe with obstructive atelectasis of the middle lobe." My feeling is, therefore, that careful examination at full inspiration and full expiration, after every operation under ether, will show in a small percentage of cases, all three types of bronchial obstruction.

There is (Fatzinger) another point I should like to make; namely, that obstructive atelectasis due to complete obstruction of a bronchus does not immediately disappear after removal of the obstruction. In other words, a lung collapsed because of a plugged bronchus does not immediately expand after removal of the plug. Why, we do not know; but as evidence that it does not do so, we have on file an abundance of graphic records in the form of röntgenograms taken before and after removal of a foreign body.

In conclusion a word as to the danger of bronchoscopy. Cough can be largely controlled, but its effect on a fresh abdominal wound is to be considered by the surgeon in the particular case. In general it may be stated

that the danger of bronchoscopy depends on how it is done. Properly and skilfully executed, it is free from danger considered apart from the condition for which it is done. Bronchoscopy by an untrained man is likely to have a high mortality even in a relatively normal patient. Sixty years ago it was dangerous to open the abdomen, in the way it was done then. When every surgeon has a bronchoscopic assistant, it will be realized that bronchoscopy is as safe and as useful as cystoscopy.

REFERENCES

[1] Cutler: Surgical Clinic of North Averica, vol. ii, pp. 935, 945, Aug., 1922.
[2] Cutler and Hunt: Arch. Intern. Med., vol. xxix, pp. 449–481, April, 1922.
[3] Pepper: Med. Clin. North Amer., 1921, vol. v, pp. 737–749.
[4] McKesson: Amer. Jour. Surg., vol. xxxii, p. 16, 1918, Quar. Sup. Anesthesia.
[5] Norris: Ill. Med. Jour, Oct, 1921
[6] Chevers: Guy's Hospital Reports, 1876.
[7] Mandl: Deutsch Zeit. f. Chir., July, 1921, p. 67.
[8] Gottstein: Klin. Arch. f. klin. Chir., vol. lvii, p. 409, 1898.
[9] Mikulicz: Zerhandl. d. deutsch. Gesellschr. f. Chir., vol. xxx, p. 560, 1901.
[10] Henle: Zerhandl. d. deutsch. Gesellschr. f. Chir., vol. xxx, p. 560, 1901.
[11] Sauerbrook: Zeitr. d. klin. Chir., vol. cxxii, p. 234, 1921.
[12] Mandl: Wein. klin. Wnschr., vol. xxxiv, p. 214, May 5, 1921.
[13] Pasteur: Amer. Jour. Med. Sciences, 1890.
[14] Bibergeil: Koerter's Clinic, Berlin, 1906.
[15] Rupp: Arch. f. klin. Chir., Berlin, Mar. 21, 1921, vol. cxv, p. 672.
[16] Pasteur: British Jour. Surgery, 1914, vol. 1, p. 587.
[17] Pasteur: Middlesex Hospital Reports, 1910, Lancet, 1080.
[18] Briscoe: Quarterly Jour. Med., vol. xix, p. 293, April, 1920.
[19] Rose–Bradford: Oxford Loose Leaf System Med., vol. ii, pp. 127–137.
[20] Norris–Landis: Diseases of Chest, 1922, p. 487.
[21] Tidy: Lancet, London, May 2, 1914, p. 1245.
[22] Grailey and Hewitt: Reynolds System Med., 1871, p. 865.
[23] Rose–Bradford: Quarterly Jour. Med., vol. xii, 1918–19, p. 127.
[24] Schroeder–Green: Amer. Jour. Med. Sc., New Series, 123, p. 196.
[25] Pearson–Irvine: Clin. Transact. Lon., vol. ix, 1876.
[26] Lictheim: Arch. Exper. Path. u. Pharm., vol. x, p. 54, 1878–79.
[27] Elliott-Dingley: Lancet, London, May, 1914, vol. i, p. 1305.
[28] Cymble: Brit. Jour. Surg., vol. v, p. 363, Jan., 1918.
[29] Pasteur: Bradshaw Lecture, London, 1908, Lancet, vol. ii, p. 1351, 1908.
[30] Scrimger: Amer. Jour. Surg., vol. xxxvi, pp. 53–60, April, 1922.
[31] Herb: J. A. M. A., vol. lxxxix, pp. 339–342, July 29, 1922.
[32] Hirschbroeck: Amer. Jour. Med. Sc., vol. clxiv, pp. 268–274, Aug., 1922.
[33] Scrimger: Surg., Gyn. and Obst., 32, 486, June, 1921.
[34] Schlotz: Med. Jour. of South Africa, Jan., 1921, vol. xvi, p. 202.
[35] Mortimer: Medical Press and Circular, vol. cviii, 1919, pp. 507–509.
[36] St. John:
[37] Hampton and Wharton: Johns Hop. Med. Bull., Apr., 1920, vol. xxxi, p. 95.
[38] Hall: Lancet, London, Jan. 15, 1922.
[39] Barling and Levestre: Manual of War Surgery, p. 191, Oxford Univ. Press.
[40] Elwyn–Girsdansky: J. A. M. A., Aug. 27, 1922, No. 9, vol. lxxix, p. 718.
[41] Elwyn: J. A. M. A., Dec. 23, 1922, vol. lxxix, p. 2154.

[41] Elwyn: J. A. M. A., Feb. 2, 1924, vol. lxxxii, p. 384.
[42] Lee: ANNALS OF SURGERY, Apr., 1924, p. 506.
[43] Leopold: Amer. Jour. Med. Sc., Mar., 1924, No. 3, vol. clxvii, p. 421.
[45] Whipple: Surg., Gyn. and Obst., vol. xxvi, p. 29, Jan., 1918.
[46] Schlotz: Med. Jour. South Africa, vol. xvi, p. 202, June, 1921.
[47] Gwyn: Trans. Amer. Asso. Phys., vol. xxxviii, p. 411, 1923.
[48] Ritvo: Amer. Jour. Roent., vol. xi, p. 337, April, 1924.
[49] Lord: Diseases of the Bronchi, Lea and Febiger, Phila., 1915.
[50] Jackson: Amer. Jour. Roent., Jan., 1924.
[51] Jackson: Therapeutic Gaz. Sept. 15, 1920.
[52] Phillips and Lafferty: South. Med. Jour., 1923, vol. xvi, p. 685.
[53] Scott: Arch. of Surgery, Jan., 1925.
[54] Manges: Amer. Jour. Roent., vol. ii, p. 517, Jan., 1924.
[55] Clerf: Surg., Gyn. and Obst., April, 1924, pp. 472–474.
[56] Jackson: Surg., Gyn. and Obst., Apr., 1924, pp. 472–474.
[57] Cutler and Hunt: Arch. Surg., vol. i, p. 114, July, 1920.
[58] Heuer: Surg. of Thorax, Keen's Surg., vol. viii, p. 351, 1921.
[59] Riesman: J. A. M. A., vol. lxxxii, p. 1256, Apr. 19, 1924.
[60] Willy Meyer: N. Y. Med. Journ. and Record, 1924, vol. cxix, p. 590.
[61] Jackson: J. A. M. A., 1922, vol. lxxix, p. 1399.

EXTRACTION THROUGH THE THORAX OF PROJECTILES LONG RESIDENT IN THE LUNG[1]

By J. J. Buchanan, M.D.
of Pittsburgh, Pa.

Very early in the recent great war, the French army surgeons were confronted with patients carrying projectiles in their lungs, whose wounds had healed, but who still had symptoms of greater or less severity—occasional hæmoptyses, purulent expectoration, dyspnœa on exertion and chest pains. The question of removing these projectiles to restore these soldiers to health and return them to duty became very acute. The credit of performing the first operation of this kind is due to Dr. Paul Mauclaire,[2] who extracted a shell fragment three months after the war began (October 30, 1914) from the lung of a man who had been wounded six weeks before. Doctor Mauclaire operated by a combined method of small thoracotomy and extraction with the forceps by the intermittent use of the fluorescent screen. Success with this method not only in the hands of its originator, but also with many other surgeons, was remarkable.

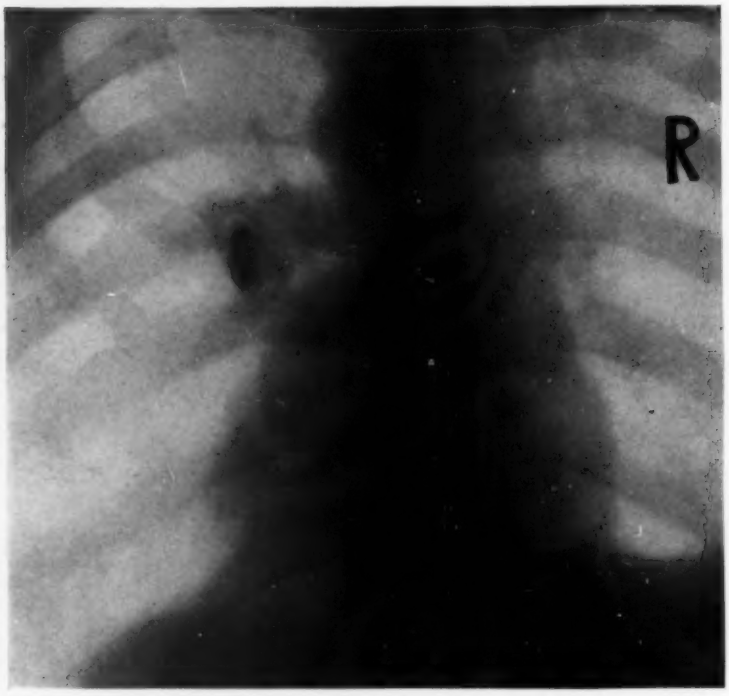


Fig. 1.—X-ray film made by Dr. Maurice Goldsmith, of Pittsburgh, before patient's admission to Mercy Hospital.

Three weeks later, the second extraction was made by Dr. G. Marion[3] by quite a different procedure. His method, well adapted to the general

[1] Read before the American Surgical Association, May 5, 1925.

[2] Bull. et Mem. Soc. de Chir. de Par., 1914, vol. xl, p. 1350, and vol. xli, p. 14.

[3] *Ibid.*, 1915, vol. xli, p. 1781.

run of surgeons, consists of localization with the X-ray; fairly liberal rib resection, if necessary, at the place most accessible to the projectile, firm anchoring of the underlying lung to the parietal pleura; incision of the parietal pleura in the centre of the anchored surface, incision of the lung to a depth sufficient to reach the projectile; palpation with the finger and removal with the forceps. It will be noted that the operation is done after localization of the projectile with the X-ray, by means of Marion's compass and no use is made of the fluorescent screen.

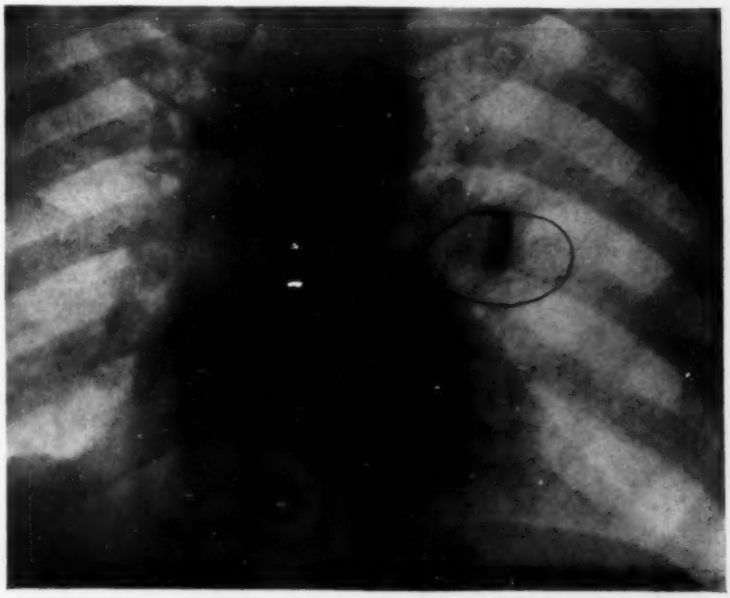


FIG. 2.—X-ray film made at laboratory of Mercy Hospital, with wire marker for localization, two days before rib resection.

I am indebted to Doctor Marion for a personal letter dated March 3, 1925, in which he says, "I have operated 153 patients carrying projectiles in their lungs. All have been operated by my method. . . . Mortality, 4 cases. (One on the table during removal of a projectile from the hilum, the extraction of the projectile opening a vessel of the lung against which it had been pressing; a second from embolism on the tenth day; two others from purulent pleurisy.)" Marion has had many followers who have reported equally good results in a smaller number of cases.

In 1915, Dr. Pierre Duval advocated and practiced the wide opening of the pleural sac, always by the technic of Willy Meyer, causing collapse of the lung by gradual pneumothorax; display of the part of the lung containing the projectile; removal of the projectile; suture of the lung wound; closure of the thorax without drainage and aspiration of the residual air.

Through the kindness of Dr. Pierre Duval, who has sent me a personal letter, dated March 5, 1925, I am able to give his own results up to this time: "(1) I have operated on about 40 cases not published. My total number of old projectiles taken from the lung is, therefore, about 80, with one death from double broncho-pneumonia. (2) I have always operated according to my own method. (3) Immediate results very good—one death in about 80 cases. Late results very good. I have followed the patients for many

months, and found good functional results and by radiography a disappearance of the pachypleuritis in the majority of cases." The mortality in this brilliant, radical and highly scientific and surgical method, in the hands of its originator, is thus seen to be only 1¼ per cent., a result which has been approximated by other surgeons in France with fewer cases.

The procedure which has had the greatest vogue in France is that of Dr. Petit de la Villéon, who developed the method, which he termed "the buttonhole" operation, while acting as Naval Surgeon at the port of Brest. This method was admirably described and warmly commended by the late Dr. Robert G. LeConte in a paper read before this Association six years ago. Doctor LeConte was an eye witness and careful observer of the extractions made at Brest by this method.

FIG. 3.—X-ray film with wire marker, lateral view, made at Mercy Hospital two days before rib resection.

The first of these extractions was made on October 27, 1915,[4] almost a year after Mauclaire's first operation.

Experiments on cadavers and animals had previously been made by Petit de la Villéon to show that a blunt forceps, pushed through the parietal pleura against the lung, would first dimple the surface and, by firm pressure, be made to traverse the lung, pushing aside blood-vessels and air tubes in its course. Experience in the removal of thousands of projectiles from other parts of the body by screen extraction, with forceps through a buttonhole incision in the skin, had made the surgeons at Brest proficient in this work and had emboldened Petit de la Villéon to try it on the lung.

The forceps extraction under the fluorescent screen by this method is prohibited by Dr. Petit de la Villéon for projectiles located at the root of the lung and in the region of the hilum.

[4] Bull. Acad. de Med., Par., 1916 (meeting of March 7th).

The rapidity with which projectiles in all other parts of the lung are removed by this procedure, in the hands of its originator and his followers, is remarkable—thirty seconds; even twenty seconds; one minute; two minutes the usual length of time. It should be remembered, however, that this is the time required by experts, and means the time actually used in the extraction itself.

This method has had its opponents who have characterized its as blind, brutal, unsurgical.

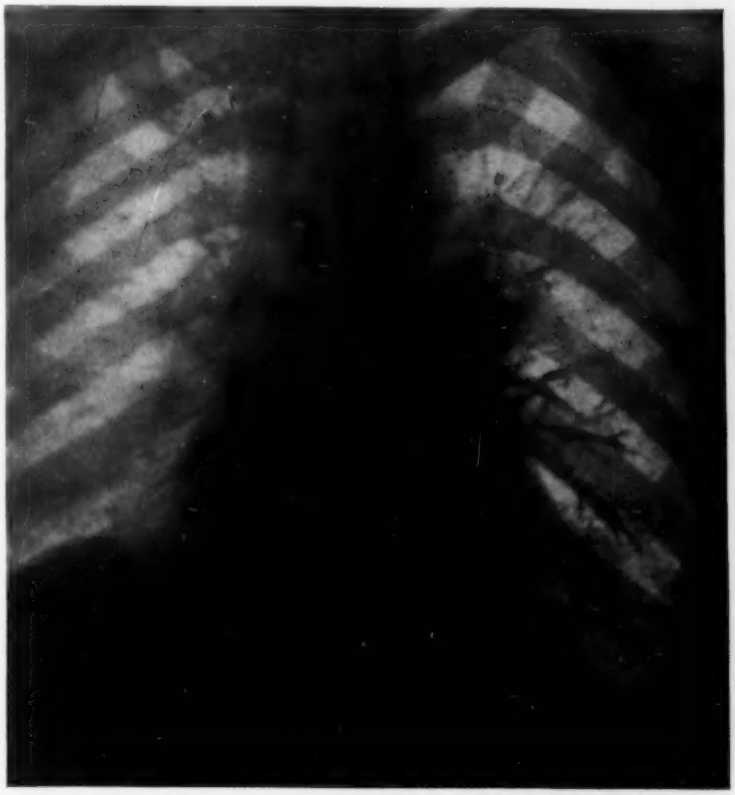


FIG. 4.—X-ray film, made for Dr. Chevalier Jackson, after insufflation of bismuth subcarbonate into left bronchus, showing relation of bullet to bronchial tree.

Doctor LeConte said: "Three things are essential for the successful practice of the method: (1) The radioscopic eye must be acquired. (2) The correlation of the two shadows made by the foreign body and the point of the forceps. This must be intuitive, without process of thought, as a dentist works by a mirror or direct sight. (3) Gentleness and dexterity of the hand. This is acquired by the removal of projectiles from less dangerous zones, as in the extremities."

Dr. René LeFort, of Lille, France, who has done remarkable work in removing lung projectiles by many methods, including his own, said at the New York Academy of Medicine in 1919: "This procedure (Petit de la Villéon's) has been severely criticized. The tearing out in the dark of an invisible projectile, surrounded by unseen blood-vessels and tissue layers, is revolting to the surgical mind. The procedure is difficult and, even after some practice, often requires prolonged groping. The projectile escapes from the forceps and is pushed back into the dark recesses of the thorax where the

presence of opaque, bloody extravasates further diminishes visibility and interferes with the exploration. The results are excellent, however, and the immediate and permanent sequelæ are extraordinarily free from complication. After lengthy explorations with the forceps in the midst of the lung tissue, the patients may be seen walking about, without disturbance or reaction of any kind, 48 hours after operation." Such is the opinion of a Master of Lung Surgery. Now, what are the tabulated results?

FIG. 5.—X-ray film (lateral view) showing relation of bullet to bronchial tree, made for Dr. Chevalier Jackson, after insufflation of bismuth subcarbonate.

By the kindness of Dr. Petit de la Villéon, who has written me under date of March 17, 1925, I may quote as follows: "By my method, more than 1000 intra-pulmonary projectiles have been extracted by myself and my friends with a mortality of 5 patients (½ of 1 per cent.). The method is classic to-day in France. It is adopted by the great majority of surgeons for its certainty, its safety, its simplicity, which made its success.

With reference to the subject of hilary projectiles, I must say that I am a partisan of the operation in two stages. The first stage has for its purpose the posterior thoracotomy and the production of pleural adhesions. The second stage (eight days later) consists of radio-operative removal of the projectile fixed in the lung and adherent. Then termination of the operation by tamponment without total pneumothorax."

Doctor Allain,[5] who assisted Dr. Petit de la Villéon in all of his early extractions, who made this the subject of his graduation thesis, and who is now

[5] Allain (J. E. A.), L'extraction des projectiles intra-pulmonaires par la Methode Petit de la Villéon: historique et description. Paris, 1922.

Dr. Petit de la Villéon's assistant in his surgical practice, says, "Providing against the remote possibility of a hemorrhage, Dr. Petit de la Villéon has always ready at hand on his instrument table the material necessary for a rapid and urgent thoracotomy to control hemorrhage in the usual surgical way. But we must say that he has never had need to use these instruments."

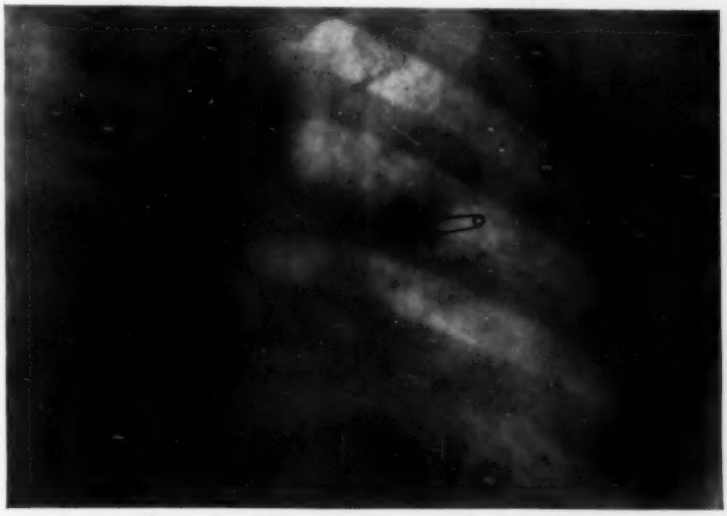


FIG. 6.—X-ray film after rib resection with safety pin as a marker, lying in the bed of the rib where resected.

The patient who brought this matter acutely to my own attention was referred to me by Dr. J. Grekin, of Pittsburgh, and gave the following:

CASE HISTORY.—Male, Hebrew, teacher, aged twenty-nine. Shot in Russia, in March, 1920, by one of Denikin's soldiers. Ball entered the left chest in front at the second interspace about two inches from the midline of the sternum. He spat some blood at once, but his wound healed in about three weeks and he was perfectly well during the following year. He then expectorated blood for three days, which he attributed to his having done heavy work. For more than two years thereafter he was perfectly well, not doing laboring work. Ten weeks before admission, however, he again began to cough and spit up some blood followed by yellow sputum. He states that in this last period he would spit up about a wine-glass of blood at a time.

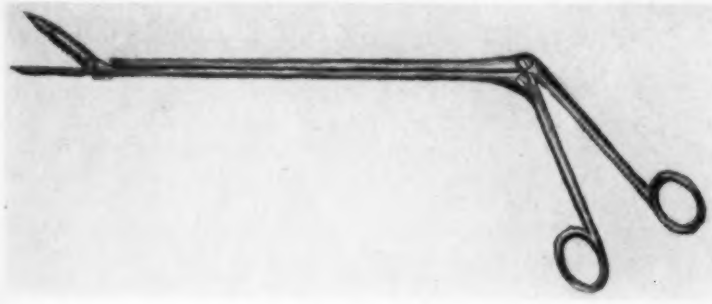


FIG. 7.—Petit de la Villéon's extraction forceps. Bull. et. Mem. de la Soc. de Chir. de Paris, 1916, vol. xlii, p. 1890.

Patient is a man with unusually massive chest and of healthy appearance. He has no physical signs of respiratory trouble. Fluoroscopic examination and X-ray films show an oblong bullet lying under the third rib and second interspace about an inch and a half from the left border of the sternum and at a depth of about three inches (7½cm.) from the anterior chest wall. Examination of the films shows the shadow of the ball to be projected against the sixth rib posteriorly and between the inner border of the scapula and the spine, which is within the trapezium

called the danger zone by Dr. Petit de la Villéon. The lateral view, however, shows the ball decidedly nearer the anterior than the posterior chest wall.

Dr. Chevalier Jackson saw this patient at my request, and expressed the opinion that "the removal of the bullet by bronchoscopy would be a dangerous procedure because of the localization of the bullet so close to the root of the lung and so near the very large vessels." I am further obliged to Doctor Jackson for two localization prints made from X-ray films of this patient's chest after insufflation of his bronchi with bismuth. Inspection of the reproductions of these films shows the ball to be in the same relative position to the bony structures as appears on our films, but gives us additional knowledge of its relations to the bronchial tree.

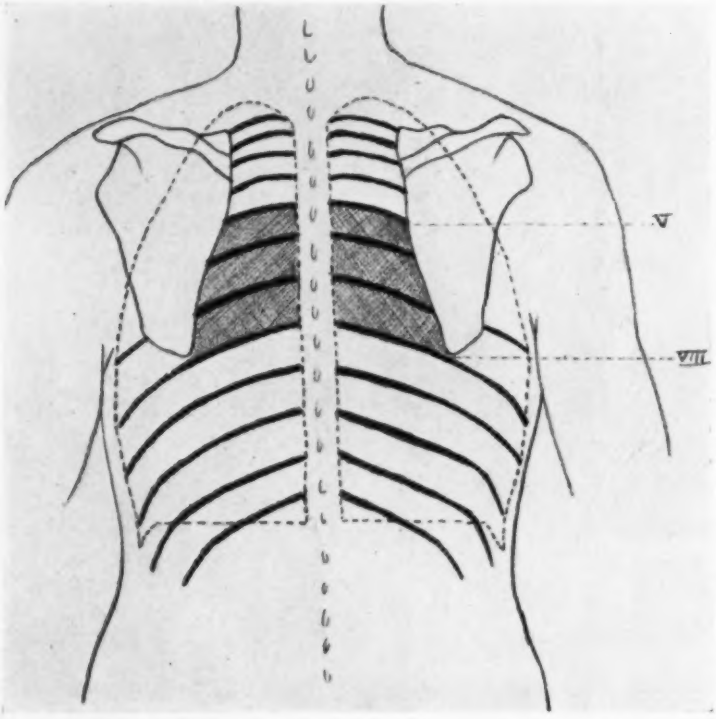


FIG. 8.—Petit de la Villéon's diagram of the "danger zone" for the Hilary region. Bull. et. Mem. de la Soc. de Chir. de Paris, 1918, vol. xliv, p. 980.

Operation.—October 22, 1923. Ether anæsthesia. Resection of 2½ inches of third rib overlying the bullet. Most striking was the tumultuous action of the underlying lung. The wound was packed openly and the patient returned to his bed.

The next day, after cocaine anæsthesia of the bed of the rib where resected, four catgut sutures were inserted, one at each end and one at each side, which took a good bite into the lung. An incision was made into the lung tissue which caused about as much bleeding as would follow a similar incision into the liver. A needle was passed about 2½ inches into the lung and contact was made with the bullet. A small amount of air was aspirated into the pleural sac; an irritative cough occurred; and the patient coughed up two or three teaspoonfuls of blood. Aspiration of air was easily stopped by light packing of the external wound.

Completion of the operation was deferred for two days. No anæsthesia was required at this third sitting. Adhesion of the pleural layers by this time was complete. Contact with the ball was again made with a needle and the track of the needle enlarged with a bistoury. The finger was then passed to the projectile and acted as a guide to a bullet forceps by which the bullet was removed.

The incision of the lung, the passage of the finger and the lifting of the projectile from its bed was followed by rather profuse bleeding; but the field was kept entirely free of blood by a suction apparatus such as is used in tonsillectomies. Very soon after the extraction the hemorrhage ceased. The external wound was lightly packed with iodoform gauze, no sutures being used.

Convalescence was uneventful. The patient left the hospital in fifteen days and has since remained well. This is the operation of Marion, of Paris, except for the fact that the operation was done at three sittings. In only seven of his cases did Marion postpone the completion of his operation till another day.

Late extraction of projectiles from the lung, according to available literature, seems to be an operation almost without vogue in this country. With the exception of Dr. Chevalier Jackson's two cases, one removed through the bronchoscopic tube[6]; the other by forceps extraction under the fluorescent screen,[7] I have been unable to find any recorded cases. The significance of this must be that bullets, which are practically the only projectiles here that lodge in the lung, give symptoms so well borne that operation is considered a greater risk than a policy of delay. I personally know of two such cases treated by colleagues.

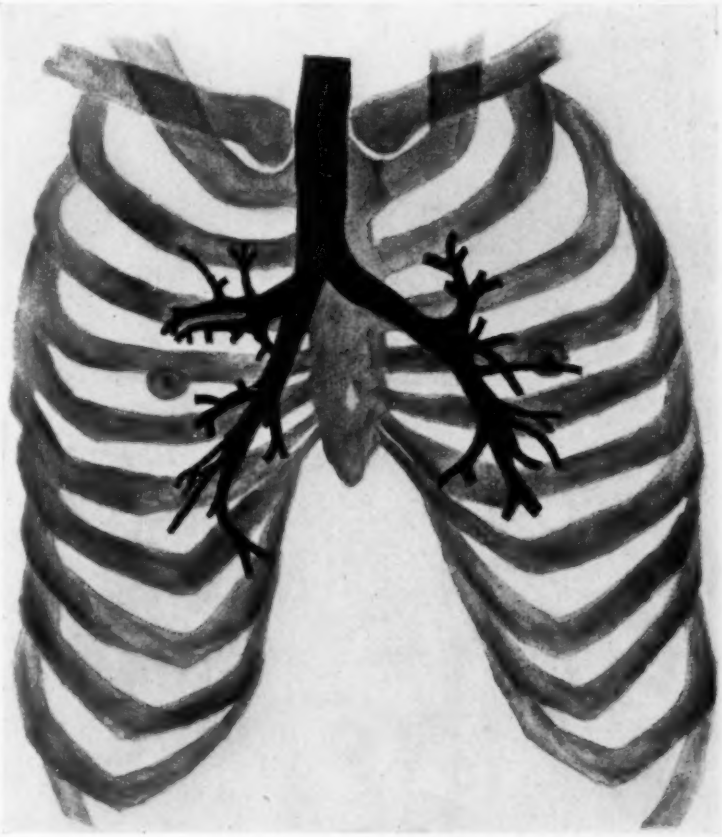


FIG. 9.—Relations of bronchial tree to anterior thoracic wall as shown by X-ray (after Blake).

Operations may have been done and not published or they may have escaped my search.

ADDITIONAL NOTES AND CONCLUSIONS

A subject so extensive cannot be covered in a paper of reasonable length; but a careful examination of the literature permits the following additional notes to be made:

[6] Journal American Medical Assoc., 1921, vol. lxxvii, p. 1178.

[7] ANNALS OF SURGERY, 1923, vol. lxviii, p. 501.

1. The method of Petit de la Villéon was developed at Brest under unique advantages. Thousands of projectiles had been removed from other parts of the body with forceps under the screen, where the surgeons had had the coöperation and aid of Doctor LeConiac, a radiologist, who had examined 21,000 patients since the war began.

2. Indications for extraction are: (*a*) Recurrent hæmoptyses; (*b*) purulent expectoration; (*c*) dyspnœa on slight exertion (as Dr. Robert Didier says, "Life for such a patient is a perpetual fatigue"); (*d*) pain (which may be from pleural adhesions); (*e*) location of the projectile in an extrahilary region; (*f*) urgent symptoms in hilary cases; (*g*) respectable size of the projectile.

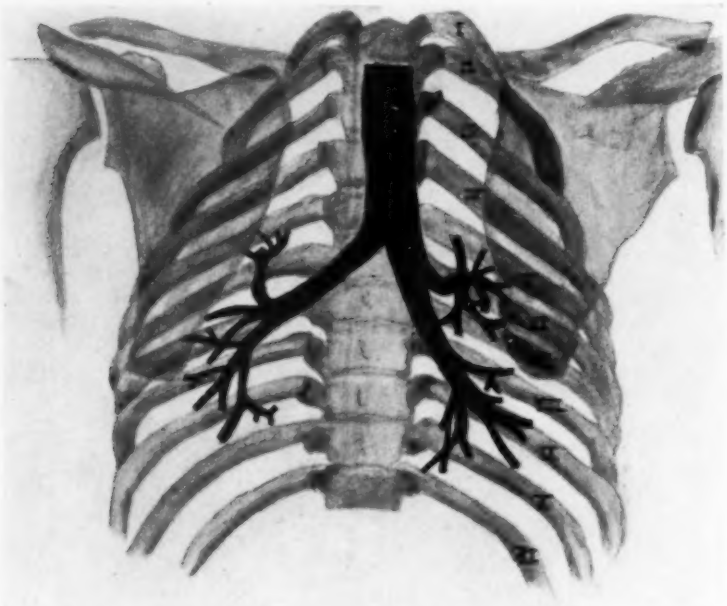


FIG. 10.—Relations of bronchial tree to posterior thoracic wall as shown by X-rays (after Blake).

3. The favorable time to operate is after the fall of temperature, the disappearance of effusions and after the wound has cicatrized (LeFort).

4. Petit de la Villéon considers essential in his operation: (1) The extreme smallness of the buttonhole incision in the skin—just large enough to carry the extracting forceps, thus preventing the slightest pneumothorax in nearly every case; (2) careful approximation of the tip of the forceps to the projectile without any misdirections (this to be attained only by much experience); (3) careful separation of the projectile from its bed by manipulation with the tip of the forceps; (4) satisfactory grasp of the projectile in its most favorable diameter and covering any sharp edges of the projectile with the forceps; (5) use of the Kocher forceps for superficial projectiles and his own alligator-jawed, blunt-tipped parallel-sided forceps for deep projectiles.

5. Objection has been made to forceps extraction under the screen that, while the projectile may be removed, débris of clothing may be left and form a focus for infection. Allain, in his thesis, states that, up to October 8, 1918 (253 cases having been then operated), "none has shown an accident of this kind and the healing has always been by first intention."

6. Drowning by flooding the bronchi with blood during extraction is so rare as to be negligible. I have noted but one case, Marion's—removal of a projectile at the hilum, treated by tamponade of the wound. In two other cases at the hilum the trachea was flooded with blood, but the patients recovered (Oudard's and Marquis'). Use of the suction apparatus in the external wound might be preferable to the tamponade.

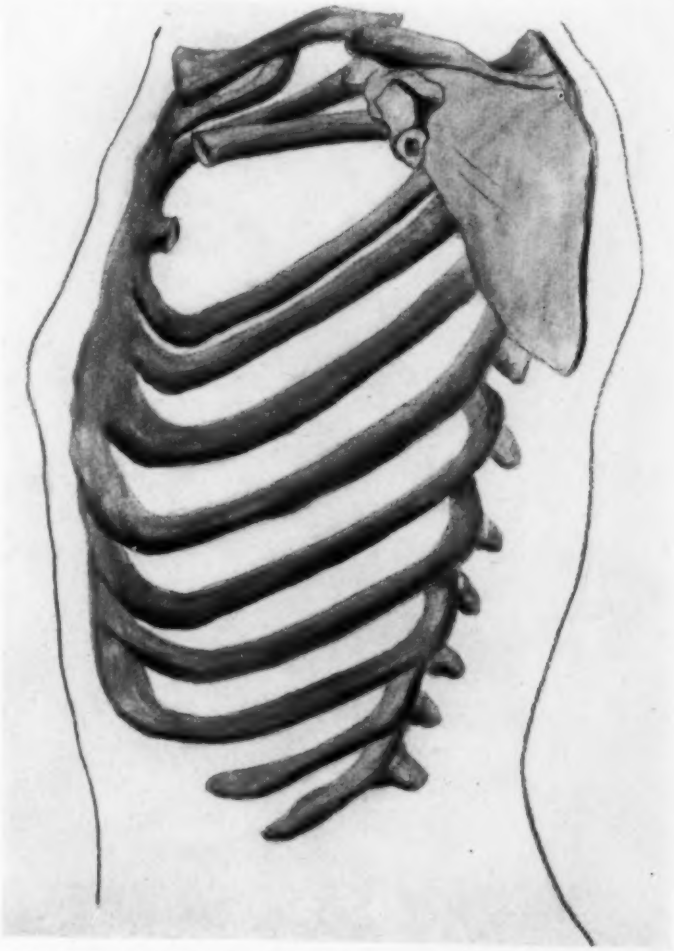


FIG. 11.—Dr. René LeFort's method of exposure of the root of the lung by incision of the third intercostal space and division of the third costal cartilage. Rev. de. Chirurgie, 1917.

7. *Projectiles at the hilum and root of the lung* are rather exceptional, for the reason that most of those wounded in this region die before they reach the surgeon (Mauclaire).

The hilary zone is not a definitely anatomical region. Practically, however, according to Petit de la Villéon, projectiles in the root of the lung or in the hilary region cast their shadows within a trapezium bounded by the fifth rib above, the eighth rib below, the inner border of the scapula externally and the vertebral border internally; and are situated at a depth of 6 to 14 centimetres from the skin of the back where the shadow has impinged.

(I must thank Dr. Joseph A. Blake for permission to reproduce a diagram of his, taken from an X-ray plate showing the relation of the bronchial tree to the bony framework of the chest.)

The approach to the hilum may be made from in front, where the chest wall is thin and flexible, a location favored by Pierre Duval, René LeFort

and Hallopeau; or from the rear, where the wall is thick and rigid. (Petit de la Villéon.)

Wide opening of the chest for exposure of the hilum and root of the lung may be made by excision of 5 to 10 centimetres of the second and third rib or by liberal section of the third intercostal space with section of the second and third costal cartilages, according to the method of LeFort, in either case followed by the use of strong rib spreaders such as Tuffier's or Lilienthal's.

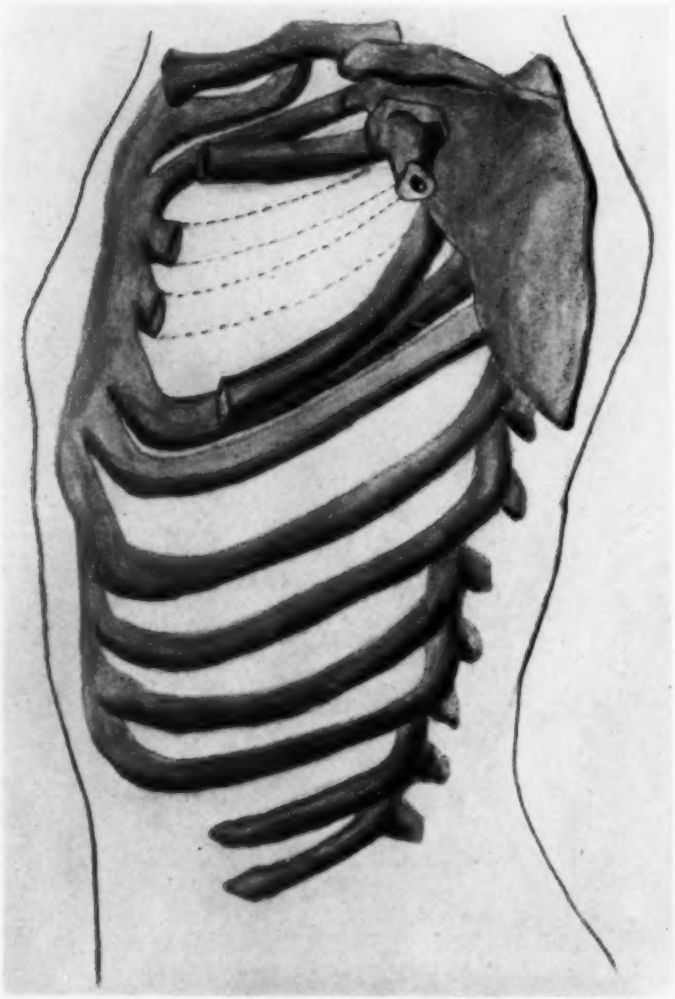


FIG. 12.—Dr. René LeFort's method by division of third and fourth costal cartilages. Revue de Chirurgie, 1917.

The approach may be made from behind between the scapula and the spine by resection of a portion of the sixth or seventh rib. This passage is deep and restricted in area and gives but hampered access to the fixed and dangerous region of the hilum which must be dealt with in place, as it cannot be delivered.

8. Dr. Pierre Duval endorsed the method of Dr. Petit de la Villéon and reported in detail the first hundred cases done by this procedure to the Surgical Society of Paris in June, 1917. Forty-four of these cases were done by Petit de la Villéon himself and the other 56 by seven other surgeons at Brest.

Not one of these seven surgeons lost a case. Doctor Duval, in making this report, said, "With us and elsewhere, the number of buttonhole extractions is increasing and the number of operators as well. . . . The cases

have not been chosen with the intention of making good statistics; they represent the uninterrupted course of our work. . . . LeConiac, as well as our operators, still ignores radio-dermatitis, although some use Mauclaire's gloves. . . . The extraction from the lung by forceps is, with the exception of the hilary region, as harmless as in the buttock, the leg or the arm. The pulmonary tissue is extremely tolerant of the action of the forceps. . . .

Knowing and having the necessary instruments for localization, we do not use them, because our method appears to us so sure and much more rapid. I have seen five projectiles removed from the thorax of four patients in forty-five minutes by Petit."

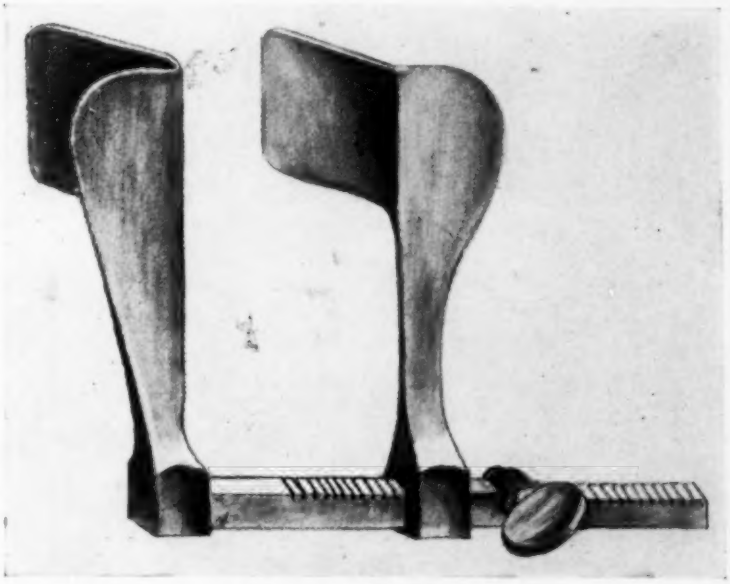


FIG. 13.—Tuffier's rib-spreader.

Conclusions of René Le Fort.—The methods for the extraction of intrathoracic projectiles have been greatly improved in the course of the world war; but the fact must not be lost sight of that, in order to guard against disappointment, interventions of this class must be positively and absolutely left to experienced surgeons, working in suitable surroundings, and never to fledgling operators whose scalpels have been let loose by the war. With these reservations, all disturbing or voluminous intrathoracic projectiles should be removed.

Robert Didier, in 1916, said, "Familiarized for a long time with extraction under the screen, we would not dare, up to this time, to approach a projectile of the thorax otherwise than on the radioscopic table. Surgeons who do not wish, or who are not able to accommodate themselves to this method of procedure ought, in the interest of their patients, to give up extractions of old projectiles from the lung."

Many French surgeons have practiced exclusively one of the four typical operations mentioned above; but many others have selected the method of operation best adapted, in their judgment, to the case in hand, and have even switched during operation from one procedure to the other according to the exigencies of the case.

It should be said, however, that whatever plan a French surgeon adopted, his results were almost always good.

I am deeply indebted to a number of distinguished French surgeons, not mentioned above, for information received by personal letters which add to and emphasize that which they have already published.

Dr. Louis Desgouttes states that he has operated on 55 patients carrying projectiles in their lungs. In only one case did he fail to remove the projectile. All the patients recovered. He always operated by the same method, a slight modification of Marion's. His localization was made with the Compass of Hirtz, an improved form of the Compass of Marion. "The late results are good, but difficult to judge; because the old wounded have a tendency to complain in order to keep their pensions as wounded soldiers or increase them."

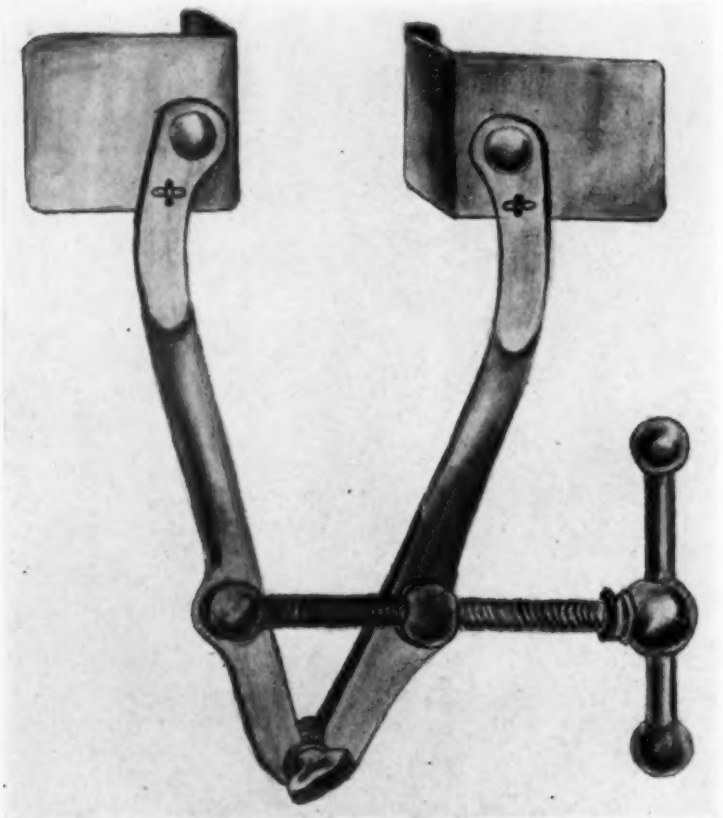


FIG. 14.—Lilienthal's rib spreader.

Dr. G. Læo has made many extractions with success, using always the open method of Dr. Pierre Duval. Some of his patients also are disposed to magnify their symptoms in order to increase their pension rate.

Dr. René LeFort has sent me the outline of a case, which he recently operated, very similar in its clinical course to my own. The projectile had been carried six years. He removed it by the method of Marion with success. Doctor LeFort also uses the procedure of Petit de la Villéon and his own modification of Pierre Duval's.

Dr. Victor Pauchet has extracted ten projectiles without loss of a patient and prefers the method of Petit de la Villéon.

SUMMARY

1. Extraction of projectiles long resident in the lung by French surgeons has been wonderfully successful.

2. Opportunity for such extractions in this country is so infrequent that no surgeon in peace times is likely to acquire the skill and dexterity necessary to remove projectiles by the method of Petit de la Villéon, except in the easiest cases.

3. Projectiles in the root of the lung or in the hilary regions should not be removed unless they provoke symptoms; and then should be approached by the open operation of Pierre Duval or by the method of René LeFort; in any case, such operations should be reserved for surgeons accustomed to open lung surgery.

4. For the extra-hilary cases, with symptoms urging to operation, in the hands of general surgeons, the operation of Marion is to be advised, as requiring no unusual technical skill and as giving an extremely low mortality.

* * *

I must thank also my hospital colleague, Dr. Paul R. Sieber, for his description of Dr. Petit de la Villéon's work, of which he was an eye witness, and the information acquired from him, after this paper was written, that he (Doctor Sieber) had successfully extracted intrapulmonary projectiles in four cases in France after he had acquired skill in working under the screen in other less vital parts.

AN EVALUATION OF PRE-OPERATIVE AND POST-OPERATIVE RADIATION IN THE TREATMENT OF MAMMARY CARCINOMA*

A PRELIMINARY REPORT

By Burton J. Lee, M.D.
AND
Ralph E. Herendeen, M.D.
OF New York, N.Y.

Introduction.—In view of the varying opinions, as to the value of radiation as an adjunct to surgery in the treatment of mammary cancer, we are presenting herewith a comparative study of the results obtained in a series of cases treated surgically with and without X-radiation. The material for the paper is furnished by patients admitted to the New York Hospital and to the Memorial Hospital during the period from April 1, 1919, to April 1, 1922. Therefore, in all cases under report, the shortest time limit after treatment is three years. The reason for selecting the date of April 1, 1919, lies in the fact that little attempt at a systematic use of pre-operative radiation had been made at the Memorial Hospital prior to this date. For some time, however, Doctors Janeway, Stone and Quick had been employing radiation before operation in a few isolated cases and had been impressed with its possibilities. From about this date, a properly planned coöperative effort has been made by surgeon and radiologist, in an attempt to apply pre-operative radiation in the treatment of this disease. In order that some fair basis of comparison can be reached, it has seemed to us necessary that the purely surgical and the post-operative cases should also be those admitted during the same period. The time factor is, therefore, a constant one.

All patients under consideration have been divided into three groups. Group 1 consists of those in which pre-operative radiation was employed, and in the major number post-operative radiation was also used; group 2 includes those individuals treated only by post-operative radiation, while group 3 contains those patients who were treated surgically, without any radiation. Through the courtesy of Doctors Gibson and Pool and their associates at the New York Hospital, the data upon the purely surgical cases have been made available to the writers, and our colleagues at the Memorial Hospital have also permitted us to include certain patients in the radiated groups.

We appreciate that in such a study there are many factors which may influence the percentage figures in any one of the three groups studied. The total number of patients is 92 and, in such a small number a slight variation in any one of the factors may alter considerably the percentage figure.

* Read before the American Surgical Association, May 5, 1925.

Among these factors of possible variation are the number of cases in each group, the surgical judgment exercised as to operability, the age factor, the character of the disease and the extent of involvement of axillary nodes.

The number of cases in each group is roughly comparable; there being 31 in the pre-operative—post-operative group, 36 in the post-operative group, and 25 in the purely surgical series.

The Criteria of Operability.—A possible source of variation in result might be found in a difference of judgment as to what constitutes operability. Patients in the pre-operative group came from the Memorial Hospital, while the patients in the post-operative series were referred to us from various hospitals in and about New York, with a considerable number from some of the larger clinics. The patients in the purely surgical group came from the New York Hospital. We believe it is fair to assume that, in general, the cross-section of surgical judgment was the same in all three groups.

Age Factor.—It will be readily seen by a glance at the following table that the ages in the three different groups allow a fair comparison.

TABLE I

Age Factor

	Youngest	Oldest	Average Age	Mean Age
Pre-operative	31	78	48	54
Post-operative	28	69	48	48
Surgical	24	75	46	49

Factor of Pathology.—In order to show to what extent these three groups may be comparable from the pathological standpoint, we have drawn up the following chart, which illustrates the number of cases of various pathological types in all three groups.

TABLE II

Pathological Types

	Pre-operative	Post-operative	Surgical
Fibro ca.	6	8	6
Adeno ca.	2	4	4
Ca. simplex	6	5	2
Medullary ca.	0	3	2
Infiltrating ca.	3	1	1
Very cellular ca.	1	0	3
Papillary cyst adeno ca.	2	2	1
Duct ca.	1	1	0
Sweat gland ca.	2	1	0
Large alveolar ca.	1	0	0
Small alveolar ca.	1	0	0
Gelatinous ca.	0	1	1
Ca. (type not stated)	6	10	6

It is confusing to attempt to compare the three groups from the pathological standpoint, when so many histological terms are used. Different patholo-

gists often apply different terms to similar histological pictures. Moreover, the cases termed carcinoma (unqualified) are to be interpreted as indicating infiltrating carcinoma of more or less active types. Moreover, in radiated cases, more fibrosis and lymphocytes reaction is encountered, giving a tendency to under-rate the original malignancy. A fair comparison will be possible if all cases are placed in one of the three histological groups; namely, papillary cyst adenocarcinoma, adenocarcinoma, and infiltrating carcinoma. On this basis the following table had been prepared:

TABLE IIa

Pathological

	Pre-operative	Post-operative	Surgical
Papillary cyst adeno ca.	2	2	1
Adeno ca.	2	4	4
Infiltrating ca.	27	30	20

It will be readily seen from a study of this chart that no one group contains a preponderance of relatively benign or highly malignant histological types.

Involvement of Axillary Nodes.—The following chart shows the number of cases in each group with and without involvement of axillary nodes as proved by microscopical examination of the specimen:

TABLE III

Involvement of Axillary Nodes

	Nodes involved	Nodes un-involved	Not stated
Pre-operative	16–57%	12	3
Post-operative	21–81%	6	9
Surgical	15–79%	4	6

It is apparent that there is little variation in the post-operative and surgical groups with respect to the percentage of cases showing involvement of nodes, and from this standpoint, therefore, these two groups are comparable. The pre-operative group shows a definitely smaller percentage of patients with axillary involvement, and for this reason alone should be expected to give a better percentage of good end results.

The Degree of Malignancy of the Process in Each Patient.—However, we believe that the most important method of comparison should be one in which the degree of malignancy is established for each patient, taking into consideration the important factors of age, rate of growth, histological appearance and extent of involvement of axillary nodes. On this basis all cases have been placed in one of the three classes: 1. Relatively benign. 2. Moderately malignant, and 3. Very malignant. The following chart indicates the types of cases which have been in each of these three classes.

TABLE IV.

The Degree of Malignancy of the Process in Each Patient.

1. Relatively benign.....	*a.* Papillary cyst adeno carcinoma. *b.* Fibro-carcinoma in elderly women without axillary node involvement. *c.* Small adeno carcinoma in middle-aged and older women, without axillary node involvement.
2. Moderately malignant...	*a.* All other cases without axillary node involvement, except those showing marked anaplasia microscopically. *b.* Fibro-carcinoma in old women, with axillary node involvement.
3. Very malignant	*a.* All young women with infiltrating carcinoma. *b.* All cases showing marked anaplasia by histological study, regardless of age or node involvement. *c.* All cases with involvement of axillary nodes, except the older women with fibro-carcinoma or papillary carcinoma.

On this basis the following chart has been prepared indicating the number of patients in each of the three classes according to the degree of malignancy.

TABLE V

Degree of Malignancy

	Pre-operative	Post-operative	Surgical
Relatively benign	3–10%	3– 8%	1– 4%
Moderately malignant	12–39%	14–39%	7–28%
Very malignant	16–52%	19–53%	17–68%

A careful study of this chart reveals that the pre-operative and the post-operative groups contain a larger number of relatively benign cases than does the purely surgical group. All of these relatively benign are at present alive and well and, we believe, that a fairer comparison can be made if they are excluded entirely from consideration.

TABLE VI

Degree of Malignancy, Relatively Benign Cases Excluded

	Pre-operative	Post-operative	Surgical
Moderately malignant	12–43%	14–42%	7–29%
Very malignant	16–57%	19–58%	17–71%

A glance at this table will show that the proportion of highly malignant cases in the pre-operative and the post-operative groups is practically identical, whereas in the purely surgical group a somewhat larger number of cases of serious types is found. The end result in the surgical group as compared to the two other groups should show a somewhat lower percentage figure of good result.

Although the number of patients studied is small, we feel convinced that the three groups are comparable for comparative statistical study.

The following chart has been prepared showing the number of patients in all three groups alive and well, dead and recurrent:

TABLE VII

Results

	Alive and Well	Dead	Recurrent
Pre-operative	16–52%	11	4
Post-operative	14–39%	17	5
Surgical	6–24%	16	3

The following chart has been prepared showing the number of patients of moderately malignant and highly malignant types alive and well, dead and recurrent, having rejected from consideration the relatively benign patients in all three groups. This chart should show more accurately the actual value of radiation in the treatment of this disease, and we believe that all statistical studies of cancer of the breast should likewise exclude the relatively benign cases.

TABLE VIII

Results

	Alive and Well	Dead	Recurrent
(Excluding relatively benign cases, all of whom are alive and well)			
Pre-operative	13–46%	11	4
Post-operative	11–33%	17	5
Surgical	5–21%	16	3

It is immediately evident that the higher percentage of the more malignant cases in the surgical group (71 per cent.) could not explain the striking difference in the percentage figure of those alive and well as compared with the two other groups (57 per cent.) and (58 per cent.). Further, it will be recalled that the percentage of (79 per cent.) surgical cases with nodes involved was considerably higher than the figure (57 per cent.) for the pre-operative group, but practically identical with that for the post-operative series (81 per cent.). A careful comparison of these percentage figures would justify a somewhat poorer end result for surgery, as compared with the pre-operative group, but it could not explain the strikingly low percentage figure obtained. A comparison between the surgical and the post-operative groups also would justify a slightly poorer end result for surgery, but not a figure two-thirds that of the radiated cases.

Our study, therefore, reveals that the relatively poor results in the surgical group must be largely explained by the fact that no radiation was applied in the treatment of these patients. Therefore, we are convinced that the results obtained at the Memorial Hospital from the use of radiation as an adjunct to surgery in the treatment of mammary carcinoma demonstrates without question the efficacy of this form of therapy. Further, our study shows that the use of pre-operative radiation adds considerably to the good end result to be obtained over post-operative radiation.

PRE-OPERATIVE RADIATION

Upon What Basis is Pre-operative Radiation Employed?—Many surgeons object to the use of pre-operative radiation upon the ground that it entails unnecessary delay in proceeding with operation and because they question its

efficacy. This view would, perhaps, be justifiable if there were not a better percentage of good results in the patients in whom this procedure was employed as compared to those treated only post-operatively.

The basis for use of pre-operative radiation depends partly upon clinical experience and partly upon histological evidence. Our clinical experience at the Memorial Hospital has demonstrated that many cases of mammary cancer show a partial regression within a few days up to a few weeks. This diminution in size is a rule rather than an exception. Tumors become better defined and in some of our inoperable cases definite mobility has been obtained where formerly fixation to deeper parts had been present. The more malignant the tumor the more ready its response to radiation and the more extensive are its clinical evidences of regression. Our clinical experiences, therefore, strongly favor the use of radiation prior to operation to convert temporarily, at least, a growing tumor into a regressive one.

From a study of histological evidence at the Memorial Hospital, Ewing believes that the changes taking place in the environment of the tumor following radiation act as a mechanical barrier, to the dissemination of tumor cells during the operation. These changes in the surrounding tissues are briefly, at first, dilation of the blood-vessels, serous exudation, lymphocytic infiltration, and later, a beginning endarteritis and a proliferation of connective-tissue cells.

Further the degenerative changes taking place in the tumor itself, probably dependent both upon primary changes in the tumor itself, as well as those occurring in the surrounding tissue. We believe that this degenerative process renders dislodged cells less viable wherever they may be carried. Moreover, the changes induced by radiation in the environment of the tumor furnish a less favorable soil in which remaining tumor cells may grow.

TECHNIC OF PRE-OPERATIVE RADIATION

Intervals of Treatment.—In general, we have found that where treatments are given in two to three-day intervals, the patient is less apt to be disturbed by radiation sickness than when treatments are on succeeding days. The patient is more likely to complete the whole cycle. It is important to explain to the patient what symptoms are liable to appear as a result of the treatment and, also, to inform her that rest combined with free catharsis and an alkaline diet are desirable, and close contact should be maintained with the patient during this period. Surgeons should familiarize themselves with the effects of radiation both local and general and should consult with the röntgenologist concerning these matters and the details of treatment employed.

The Areas to be Treated.—As a rule we expose four areas—namely: the first two over the breast proper, the last two over the axilla and supraclavicular regions. The first treatment over the breast proper is from in front and the second is from the side, thus using an additional portal of entry and, thereby, doubling the dose to the tumor and its environment. The latter two augment the dose into the axilla. The axilla is radiated whether or not axillary nodes

are palpable, for we have shown that there is a possibility of error of 15 per cent. in determining the presence or absence of involved axillary nodes.

A large area is exposed at each treatment and in the average case measures 15 x 15 cm. The reasons for using such a large area are numerous. The first is that the entire disease and the surrounding normal tissues may be fully radiated, for if one limits radiation only to the palpable tumor, we fear that, in some instance, outlying non-palpable disease or its environment might escape radiation. Another reason for selecting large areas is that the larger the skin surface, the greater will be the depth dose because of the scattered radiation produced. Further, it seems desirable to limit the actual number of treatments and the number of visits in so far as is consistent with the administration of an adequate dose.

The Dose to be Employed.—The time of exposure has varied with the area treated from 7 to 15 minutes over the breast itself, and from 15 to 25 minutes over the axilla and supraclavicular areas. The shorter exposures were in the earlier years but the tendency has been to lengthen the time, and, more recently, the 25-minute exposures have permitted an intermediate dose between the usual low voltage and high voltage. The voltage employed is 140 k.v. with 4 milliamperes of current, backing up a 10-inch spark gap with 4 millimetres of aluminum filter at a target skin distance of 10 to 12 or 15 inches. This dose is usually followed by a first-degree erythema, appearing in from one to two weeks, and followed by a slight pigmentation which is apparent in from three to five weeks. The treatments, therefore, extend over a period of about ten days.

In applying radiation every patient must be considered as a distinct clinical problem apart from any other patient and the radiation to be given must be determined as the best for that patient.

The Interval between the Last Treatment and Operation.—Although many of the patients in this report were operated upon a few days after the last exposure, we feel that best results may be obtained if an interval of at least three weeks is allowed to elapse before operation is undertaken. By this time the histological changes in the tumor and environment are more fully established.

Does Pre-operative Radiation Make Operation More Difficult?—In our experience with the cases treated in this manner, an operation performed any time from a few days to a few weeks after radiation is attended with no additional difficulties. It is only in those cases operated upon some months after massive over-radiation where the operator may encounter some fibrosis. Further, when operation is undertaken a few days after radiation, additional hæmostases may be necessary because of the post-radiation hyperanæmia present.

Does Pre-operative Radiation Affect Wound Healing and Does It Invite Wound Infection?—We have seen as many cases with delayed wound healing where surgery has been used without any preliminary radiation as where a pre-operative cycle has been employed. With the technic carried out at the

Memorial Hospital, which does not attempt a massive gross destruction of tumor process by very heavy radiation, wound healing has been satisfactory. When heavy dosage has been employed an operation undertaken a few days later, at the height of the inflammatory reaction may result in delayed healing and invite wound infection, but we have seen no such results at the Memorial Hospital.

POST-OPERATIVE RADIATION

Upon What Basis is Post-operative Radiation Employed?—In general surgeons have been more willing to submit their patients to post-operative radiation than to pre-operative treatment in the belief that the likelihood of local recurrence in the operative field was thereby diminished.

An opportunity to observe a large number of recurrent cases at the Memorial Hospital sent to us from the local clinics in and about New York leads to the inevitable conclusion that, even with the best surgical technic, dislodged tumor cells may be left in the operative field, or have escaped removal. This being the case, the reason for using post-operative X-ray is immediately apparent. In proper dosage it produces similar changes to those already outlined under pre-operative radiation, namely: an inflammatory reaction in the tissues of the operative field which thereby become less favorable as a soil for the growth of tumor cells present. It also induces similar degenerative changes in tumor cells remaining.

TECHNIC OF POST-OPERATIVE RADIATION

Intervals of Treatment and Areas to be Treated.—These are usually given twice a week, the same area being exposed as in the pre-operative cycle.

The Dose to be Employed.—The dose used over the supraclavicular and axillary spaces is relatively somewhat heavier than those over the anterior chest wall; the technic being the same as that already described under pre-operative radiation.

The breast having been removed, only a superficial dose is necessary over the anterior chest wall, whereas for the axilla and the supraclavicular regions, a relatively greater depth dose seems indicated.

The Interval between Operation and the Beginning of the Treatment.—Treatments are begun from two weeks to one month after operation when the wound has entirely healed and the patient has fully convalesced. A period of about five weeks should be allowed to elapse between the last pre-operative exposure and the first post-operative treatment. This dose may be repeated once or twice, the cycles being separated by intervals of two to three months. At present it seems highly desirable to follow such a plan of repeated fractionated dosage rather than to rely upon a single massive dose given post-operatively.

The Importance of Correct Dosage.—The results obtained in the treatment of mammary carcinoma by X-radiation depend very largely upon the dose administered. So small a dosage may be employed that practically nothing

may be accomplished. It is also true that such heavy doses may be used that the patient's local and general resistance against the disease may be markedly lower. Numerous reports may be found in the literature corroborating this statement.

CONCLUSIONS

1. Although the series includes a relatively small number of patients, the present study has convinced us that pre-operative and post-operative radiation are of value as an adjunct to surgery in the treatment of carcinoma of the breast.

2. The best results were obtained when both pre-operative and post-operative radiation were employed.

3. The end results will be largely determined by the plan of X-radiation followed and the dosage employed.

SPLENECTOMY FOR PURPURA HEMORRHAGICA*

By Malvern B. Clopton, M.D.

of St. Louis, Mo.

FROM THE SURGICAL DEPARTMENT OF THE WASHINGTON UNIVERSITY MEDICAL SCHOOL

In the past decade since splenectomy has been practiced for purpura hemorrhagica, there has been sufficient experience to make us feel that the results are more encouraging than in any other comparable group of blood diseases of uncertain origin, except perhaps in hæmolytic jaundice treated by splenectomy. The acceptance of splenectomy as a curative procedure has led to the reporting of brilliant results as observed immediately after operation, and one can easily understand the enthusiasm of the observers who have seen the almost hopeless situation change into a progressive improvement immediately following splenectomy. While a few of the cases have been reported in sufficient detail in their after course over a long period, one may think that perhaps our statistical reports are charged with a greater optimism than is justified until all these cases have been followed for several years.

As a clinical entity purpura hemorrhagica has been fairly defined for about 150 years (Morbus Maculosis Werlhofii), but our ignorance of the true nature of the disease leaves its place in the classification of purpuras in controversy. More recently, it has been suggested that primary purpuras be classified into (1) those in which there is a diminution or apparent absence of platelets; (2) those that have no change in the number of platelets, the latter probably resulting from changes in the capillaries or in other elements of the blood.

In the study of some cases with purpura and bleeding, we find difficulty in definitely placing them, but we can accept for our purpose a definition of purpura hemorrhagica as a disease usually beginning in early life, but which may come on at any age, showing petechia or purpuric spots, with serious hemorrhages from the gums or mucous membranes, with secondary anæmia (commensurate with the severity of the bleeding), the disease having remissions, or coming in cycles, and usually progressing with each attack. The small number of platelets or their absence, the prolonged bleeding time, the normal coagulation time, and the failure of the clot to retract, are the outstanding blood finding.

The spleen may or may not show an enlargement. There is an acute form which may prove rapidly fatal, and a chronic form which may continue over years.

To review at length the various opinions of this disease and the conflicting views expressed about the relation of the different blood factors is hardly necessary, as this has been so recently and ably done by several observers. (Brill, Krumbhaar, Cohn.)

The platelets, which are found in such small numbers or entirely lacking in

* Read before the American Surgical Association, May 5, 1925.

all cases of purpura hemorrhagica, play an important rôle and Eppinger believes the disease should be called thrombocytopenic purpura hemorrhagica. Their absence in purpura was first noted by Denys in 1887. Wright's demonstration of the origin of platelets in the megacaryocytes of the blood-forming organs has been generally accepted, and this function is probably normally maintained in purpura. They are considered to supply a thromboplastic substance that hastens coagulation. If the platelets are formed in normal numbers, we must account for their disappearance. Kaznelson believes that the destruction of the platelets takes place in a diseased spleen, because he found a large number of platelets in the lymph-spaces of the spleen. Frank, on the other hand, thinks that there is a failure of the megacaryocytes of the bone-marrow to produce platelets, and that the bone-marrow is activated to increased platelet production by splenectomy.

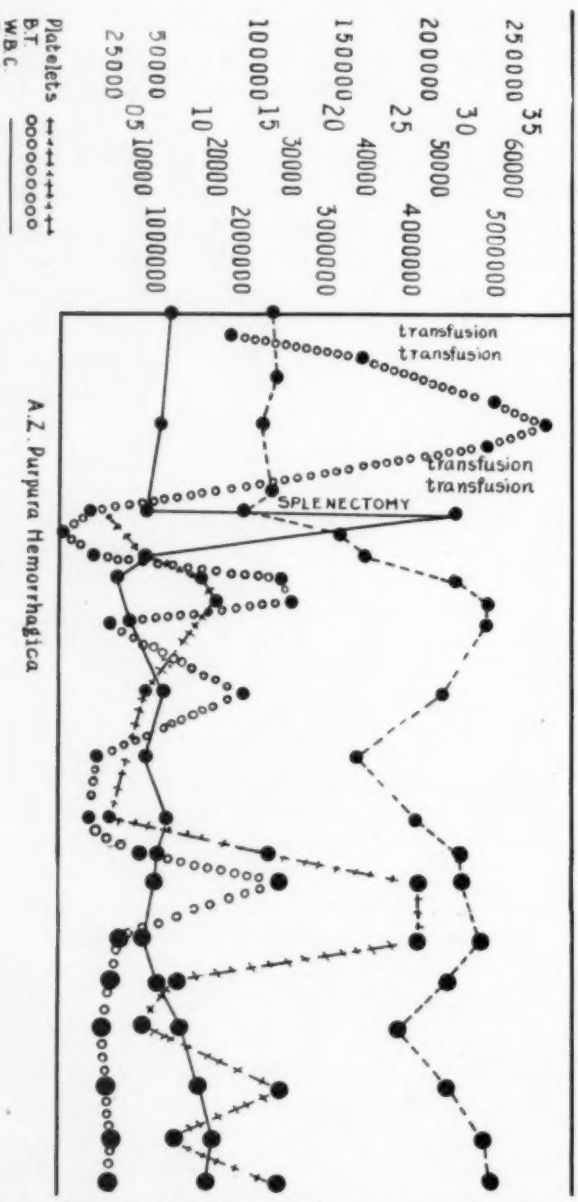


FIG. 1.—Chart showing influence of splenectomy upon the number of platelets in the blood.

The blood in purpura hemorrhagica clots normally, but the failure of the clot to retract, as normal blood does within an hour, is probably due to the lack of platelets. This at once differentiates this group of bleeders from hæmophiliacs, whose clotting time is markedly delayed and imperfectly executed, though after clot formation, clot retraction takes place, as the number of platelets in hæmophilia is normal.

The bleeding time in purpura is prolonged which is probably due in part to a vulnerability of the capillary vessels. This capillary weakness, combined with changes in the blood itself, accounts for the appearance of petechiæ, purpuras or ecchymoses of the skin and mucous membranes, and the hemorrhages that may occur from the gums, nose, stomach, kidneys and uterus or beneath the retina. Hemorrhages do not stop with the administration or application of any known remedy.

The anæmia that develops with the repeated hemorrhages varies with the amount of blood lost, and the capacity of the bone-marrow to form new cells. There may be no leucocytosis, but if it is present the increase is largely due to the increase in the mononuclear lymphocytes.

Kaznelson in 1916 suggested splenectomy in these cases and since then a number of reports of results following operation have been published.

Krumbhaar has collected 27 cases with two post-operative deaths (7.4 per cent. mortality) and no subsequent deaths. One of these cases was unimproved, 9 were improved, and 15 were apparently well. To these 27 cases I have been able to add 18 more, making a total of 45 cases with two operative deaths, 27 are regarded as well, 15 improved and one unimproved.

Two cases, from the St. Louis Children's Hospital, have been operated by me, both of them over fifteen months since, one with such marked improvement that it can reasonably be called a cure; the other with marked improvement, but with occasional hemorrhages that are easily controlled. A more recent case in the Barnes Hospital, a woman thirty-four years old, has had no reappearance of purpura or hemorrhages since her operation eight months ago.

The two cases in children had their first indication of the illness at the age of five years; one began as a mild, apparently simple purpura with only skin manifestations, but became severe after repeated nose bleeds, which started during a bad cold and otitis media. The other began with an influenza, the petechiæ and purpuric spots showing in successive crops before the bleeding started from the nose and gums. Both had been given numerous remedies by mouth and subcutaneously without effect. Transfusions had been repeated and not only had there been no influence on the bleeding, but on two occasions with the boy, fresh skin lesions and bleeding appeared almost immediately after the transfusions, an occurrence which was noted by Brill, who states that he thinks transfusion of blood has no curative effect, with which we agree. The anæmia was marked, the boy showing a red count of 3,600,000 and the girl showed a count of 2,500,000 red cells, after a transfusion that had been given to her immediately on admission because of extreme weakness. The boy came to operation almost exsanguinated from his bleeding, which repeated transfusions failed to combat. He was a bad risk for operation and it appeared for a time rather dubious whether he would survive the shock, despite the transfusion started during the operation. The girl was in better condition for operation, and responded well to the transfusion given at the time of operation. After removal

of the spleen from the boy, the oozing seemed to stop immediately from the surfaces left exposed by the tearing of adhesions. One hour later, the bleeding time was less than a minute, while it had been thirteen minutes before operation. The girl's bleeding time before operation had varied from thirty-seven minutes, seven days before operation to twelve minutes as she came to the operating room. Shortly after the operation the bleeding time was two minutes and bleeding from the nose was noted as stopping while the child was still on the operating table. The spleen in each instance was normal to microscopic examination. The one from the boy was rather large, the other normal in size. The short bleeding time persisted for a considerable period after splenectomy. In each case there was an immediate increase in the leucocyte count, with the boy, who had a count of 12,000 before operation, there was a jump to 50,000 in two days—with the girl, from 11,000 before operation to 53,000 the evening of the same day. The smears of the blood of the boy showed a remarkable pouring out of normoblasts and megaloblasts, in several fields as many as five or six nucleated reds. The girl showed only a few nucleated reds after operation.

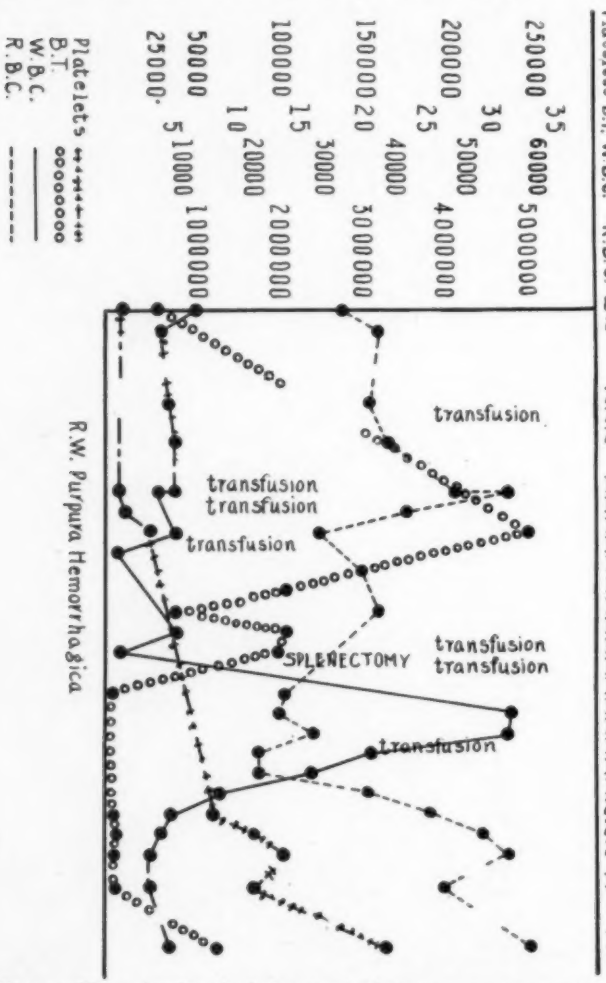


FIG. 2.—Chart showing the influence of splenectomy on the number of platelets in the blood.

The platelets, which had been hard to find before operation, showed on smears of the boy's blood a few hours after operation, but it was two weeks before they could be counted as much increased, when they numbered 60,000. They rose to 95,000 six weeks after operation, and during the first few months never got any higher, in fact, they appeared to gradually reduce in number, but the amount nine months after operation showed they were 150,000. The other child showed a few platelets on the smears six hours after operation, but it wasn't until ten days after operation that they were noted at 50,000, slowly rising to 90,000 one month after operation, and ten months after operation the count was 200,000, which is her highest count. There have been some variations in the count which I will discuss later.

The bleeding time remained at the low level in both cases for some time, and during this period there was no bleeding except an occasional slight oozing from points in the nose where previous to operation there had been brisk hemorrhages. This later oozing stopped either spontaneously or after pressure on the outside of the nostril and did not require packing.

While the boy's bleeding time remained about two minutes, he had several small hemorrhages from the nose at long intervals, from an ulcer on the septum. A virulent culture of diphtheria bacilli was grown from the nose, but whether the ulcer was due to this infection, or a result of the old weakness, one cannot say. The ulcer was very sluggish, and on last reporting the boy was still carrying the virulent organisms, but there has been no bleeding, only an occasional purpura, and the youngster is in robust health.

The girl's bleeding time remained low for several months, and there were no hemorrhages, but on one visit to the hospital three months after splenectomy, when she came to have her tonsils removed, the platelets were 50,000, the bleeding time was noted at fourteen minutes and she had a purpuric eruption, therefore, the tonsils were not touched. Eight months after splenectomy the bleeding time had returned to two minutes, but there were petechia and ecchymosis over the body, however no new petechiæ were brought out on the arms when the tourniquet was applied (capillary resistance test of Hess). There were only 20,000 platelets, which made us hesitate to subject her to tonsillectomy, which was indicated because of their large size and the fact that whenever she had an attack of tonsillitis she broke out with many petechiæ and purpuric spots. Under proper care in the country she showed the first marked improvement in general condition since her splenectomy. In the first seven months there had been a gain of only three pounds, but she felt well and seemed strong, while in the next six weeks in the country, she gained four and one-half pounds, and her red count jumped from 3,400,000 to 4,650,000, and the platelets rose to 106,000, with a bleeding time of five and one-half minutes. A month later she had gained in weight to what was normal for her age and height, she seemed robust, and had no anæmia, with a platelet count of 200,000, but a bleeding time of sixteen to twenty-five minutes, which would seem to indicate that there is some other factor than the diminution of platelets which helps determine the long bleeding time. In another month during which she continued to gain, and had not bled, the bleeding time returned to three and one-half minutes. A tonsillectomy was performed under gas oxygen with no more bleeding than is customary after this operation. It is interesting to note that thirty minutes after the operation the child broke out with petechiæ over the face, neck and forearm. These had disappeared in ten days, when the second tonsil was removed and another crop of petechiæ made their appearance within forty-five minutes. The platelet count at this time was 90,000, bleeding time three minutes, and while there was no unusual post-tonsillectomy bleeding, on the succeeding day the child began to bleed profusely from the nose, which had to be packed to control it. It is three months since the tonsils were removed and the child is in excellent health, strength and weight, with 5,000,000 red cells, a platelet count of 120,000 and bleeding time of two minutes, a clotting time of four and one-half minutes, but her clot does not retract. During these last few months she has had three hemorrhages from her nose, one quite profuse, and each time we have found the platelets count reduced to 45,000 or 50,000, but the bleeding time, usually determined by the same observer, has been around two minutes. In each instance we believe we could connect the bleeding with an upper respiratory infection.

Another interesting phase of this child's case was that she was practically blind on admission and Dr. Lawrence Post found an optic atrophy, which he thought was due to the extreme anæmia following an earlier severe hemorrhage. He regarded the eye condition as stationary, but as her general condition improves, she uses her eyes better and has been able to do some work in the hospital school. She will have to complete her education in a school for the blind.

The third case, a woman thirty-four years of age, was admitted to the Medical Service of Barnes Hospital on September 22, 1924. One month before she bruised herself and developed a large black and blue area which was slow in disappearing, then other smaller areas and spots on arms and legs were noticed which began as red, turned blue, then brown, and disappeared.

Four months before admission, after a severe cold, she developed a sinusitis and the left maxillary sinus was operated at the City Hospital. When the packing was removed from the nose there was a severe hemorrhage and subsequently up to September 7, there were several unaccountable hemorrhages from the nose.

On admission to the hospital there were scattered purpuric spots over the legs. The

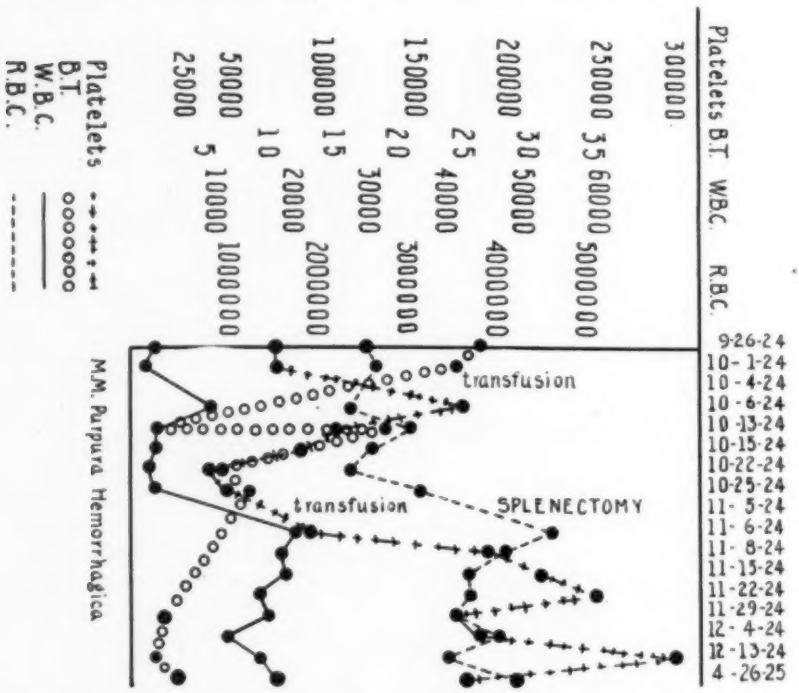


FIG. 3.—Chart showing the influence of splenectomy on the number of platelets in the blood.

patient was fat and flabby, with marked pallor. The spleen was enlarged, the liver edge could be felt. Red blood-cells 2,700,000; white blood cells 3500; differential count normal. Hæmoglobin 40 per cent.; platelets 70,000; bleeding time four minutes, and two days later eight minutes. Clotting time three minutes. Clot did not retract after two hours. There was occult blood in the stool, but on admission no other evidence of bleeding.

Patient was transfused and had a severe reaction followed by an herpetic eruption about the lips, and subsequently there were hemorrhages from these cold sores and from the gums and nose. The patient was worse after the transfusion. The bleeding time rose from seven minutes before, to nineteen minutes when taken ten days after the transfusion. She developed a transient jaundice.

Through a left rectus incision the enlarged spleen was removed. The liver was cirrhotic. There was no trouble with bleeding from the few adhesions torn during the operation, as oozing stopped as soon as the spleen was out. Patient had a stormy time after operation, developed a pneumonia of the left base and had a severe cough, which

broke some of the silkworm gut sutures, and the abdominal wound gave way, requiring a secondary suture ten days later.

Despite these serious complications and the very poor condition of the patient before operation, for the first few months she has made a steady improvement. The platelets rose to 250,000 two days after operation and have stayed between 175,000 and 250,000 ever since. The bleeding time dropped to three and one-half minutes and has stayed there since. The leucocytes rose to 20,000 after operation and have not gone below 12,000. The red cells stayed between 4,500,000 after operation and 3,500,000 a month later. The hæmoglobin has increased from 35 per cent. to 45 per cent. No purpuric spots have appeared and there has been no bleeding.

The menstruation, which had been prolonged to over a week the two periods before operation and had been most profuse, was recorded as three days and normal since operation.

About four months after the spleen was removed, when the patient had gained enough strength to return to her work in a shoe factory, she had a severe injury in an automobile accident, in which she received a fracture of the pelvis and several other bones. No unusual ecchymoses appeared, and there was no unusual bleeding from her wounds. She has recovered in a satisfactory way from these injuries and is up and about. A blood count made almost six months after the splenectomy records red blood-cells 4,060,000, white blood cells 19,600, hæmoglobin 49 per cent., differential count: polymorphonuclears 64 per cent., small mononuclears 35 per cent., large mononuclears 1 per cent. Bleeding time two minutes. Clotting time five minutes. Clot retracted in one hour. Platelets 180,000.

With these findings one can feel warranted in expecting a cure of the purpura.

TABLE I.

Cases of Splenectomy for Purpura Hemorrhagica.

	Cases operated	Well	Improved	Unimproved	Dead
Krumbhaar ...	27	15	9	1	2
Mayo Clinic...	8	4	4		
Vincent.....	3	3			
Ricardo.....	2	1	1		
Cohn	1	1			
Blumer	1	1			
Clopton.....	3	2	1		
	45	27	15	1	2

It would seem that the platelets are the most important factor so far discovered in this disease, and their decrease as is found in purpura hemorrhagica is not explained. The decrease may possibly be due to infection of the upper respiratory tract.

Taking out the spleen has been followed by an increase in the platelet count, not only in purpura hemorrhagica, but in Banti's disease. The platelet count may be slow in rising after splenectomy and it may recede after it has reached a normal number.

The hemorrhages of purpura seem to come when the platelet count is the lowest. The platelet count usually is low with a long bleeding time. The bleeding time is not necessarily short because of a high platelet count, as we have seen a long bleeding time with a high platelet count.

We agree with Brill, who feels justified in saying that splenectomy in this

disease is a life-saving measure, and should as such be employed in all cases of chronic thrombocytopenic purpura.

There is evidence that it is also curative. Kaznelson's first case had no recurrence in a period of over five years.

The risk of operation is obviously greater as the patient is weakened from repeated hemorrhages, and should therefore be performed as early as a positive diagnosis is made. The mortality is surprisingly low in the reported cases.

BIBLIOGRAPHY

Brill: Am. J. Med. Sc., 1923, vol. clxvi, p. 503.

Krumbhaar: Am. J. Med. Sc., 1923, vol. clxvi, p. 329.

Cohn: Surg., Gyn. and Obst., 1924, vol. xxxviii, p. 506.

Kaznelson: Wien. klin. Wchn. Schr., 1916.

Ricardo: Bull. et Mem. Soc. d. hôp. Par., 1924, vol. xl, p. 493 (abst. in S. G. O., September, 1924, p. 253).

THE SEQUELÆ OF GASTRO-ENTEROSTOMY*

THE INDICATIONS FOR DISCONNECTING THE ANASTOMOSIS, AND THE TECHNIC OF THE OPERATION

By Donald C. Balfour, M.D.

of Rochester, Minn.

Of all the operations for benign lesions of the stomach or duodenum, gastro-enterostomy has the widest range of usefulness. When indications are adequate, gastro-enterostomy leaves little to be desired, and, when properly performed, immediate and late complications or disappointing sequelæ are rare. It can often be employed when other methods of treatment are contra-indicated; and since simplicity, safety, and efficiency are its outstanding features, it has become the most firmly established surgical operation on the stomach.

Because of the popularity of gastro-enterostomy and because the conditions for which it is performed are either becoming more common or are more often recognized, or both, the operation has been, and is being, performed innumerable times. The results of gastro-enterostomy are not perfect, and no such claim should be made at present for this or any other treatment for chronic peptic ulcer. The imperfect results comprise, in the aggregate, a group which, although small compared to that in which results have been permanently satisfactory, is sufficient to form an apparent basis for criticism of the operation, and to present problems difficult of solution to the internist and, particularly, to the surgeon. In certain of these failures, secondary operation, which usually includes the uncoupling of the anastomosis, becomes advisable; and since this latter group offers some very interesting points for discussion, I have reviewed the 343 cases in the Mayo Clinic, in which the disconnecting of the anastomosis has been at least part of the secondary operation. It is hardly necessary to state that within the compass of one paper such a review can be only general and that this paper is but introductory to the subject.

In these 343 cases ninety-nine of the patients had had the primary operation in the Clinic, and 244 had had it elsewhere. The 343 cases can be divided readily into two groups; those in which the gastro-enterostomy appeared to be unnecessary, and those in which it apparently had been necessary. In the first group there are 131 (38 per cent.), in the second group 212 (62 per cent.).

Group 1.—The unnecessary gastro-enterostomy is a discredit not to surgery, but to the surgeon. In the earlier days of gastric surgery it was not realized that conditions other than ulcer could give rise to symptoms which mimicked perfectly those due to ulcer, and consequently gastro-enterostomy was often performed unnecessarily. The operation was also performed

* Read before the American Surgical Association, May 4, 1925.

in cases of digestive disturbance of a purely functional character; for pylorospasm, for the prolapsed atonic stomach, for gastric hemorrhage supposedly due to ulcer but in reality due to causes extraneous to the stomach, and for gastric symptoms due to disease elsewhere in the abdomen. Not only did gastro-enterostomy prove to be useless for all such conditions, but in many cases it added new symptoms to the original complaint.

Since the only basis for gastro-enterostomy is a demonstrable lesion, it is usually well to follow the rule that the operation should not be done unless a lesion can be found. The surgeon, however, is confronted with a perplexing, but fortunately rare, problem when the history is typical of ulcer, when gastro-intestinal hemorrhages have occurred, and when the X-ray report is positive, but exploration does not reveal a lesion by the usual methods of inspection and palpation. Under such circumstances the surgeon should inspect the mucosa by opening the duodenum or the stomach, or both; but since the entire mucosa cannot be inspected carefully enough to exclude the possibility of a small superficial lesion, there may be an occasional case in which the pre-operative evidence of ulcer is so definite that gastro-enterostomy is justified. If necessary, the anastomosis may be disconnected later. Another confusing type is that in which there is marked hypertrophy of the pyloric muscle. This hypertrophy may closely simulate the induration of an ulcer, but, as Moynihan has pointed out, an ulcer crater practically never occurs in the pylorus itself, even though the induration may involve the pyloric ring extensively. A chronic gastric ulcer, regardless of its size, rarely escapes recognition if a careful search is made, because of the induration about the crater and because of the characteristic changes in the serosa at the site of the lesion.

In reviewing the pre-operative histories of this group of 131 cases of unnecessary gastro-enterostomy, the most outstanding fact was the absence of a history on which a diagnosis of ulcer could have been justified at any time.

The evidence that the gastro-enterostomy was unnecessary in these cases is based on: (1) the symptoms for which the operation was done; (2) the findings at the time of operation; (3) the effect of the operation on the symptoms; (4) the nature of all the new symptoms; (5) indications that some extra-gastric condition was responsible for the symptoms; and (6) the röntgenologic findings.

The history of the patient before operation is often not only sufficient to rule out ulcer, but at the same time it may be typical of some other abdominal disease, particularly disease of the gall-bladder or appendix. Information as to the conditions found at the time of the gastro-enterostomy is usually vague and may be entirely lacking, so that little, if any, reliance can be placed on information from the patient. The effect of the operation on the symptoms may be beneficial for a short time, particularly in the enteroptotic type, since such patients are often temporarily improved by any operation or treatment which promises relief and inspires them with new hope. Sooner or later, however, the original complaint returns, aggravated by disappoint-

ment, and frequently with new symptoms directly attributable to the useless gastro-enterostomy. Nausea and vomiting are the predominating sequelæ of the unnecessary gastro-enterostomy; the latter may vary from an occasional and slight regurgitation of bile to the type of the true vicious circle with its associated features of loss of weight and appetite, and general disability. Pain is uncommon. In many cases there is sufficient evidence to determine the condition which was responsible for the original complaint which may have been appendicitis, cholecystitis, pancreatitis, splenic disease, colitis, the gastric crises of tabes, or pelvic disease. Fluoroscopic examination is of great aid since it enables one to visualize the stoma, the pylorus, and the duodenum; and when it is suspected that the gastro-enterostomy was unnecessary a röntgenologic report of a free stoma and no deformity of the duodenum is extremely valuable. The indications for operation in such a group of cases are not always clear, but even so, the symptoms may be sufficiently distressing to justify exploration, and with the approval of the patient it may be undertaken, to determine whether the anastomosis is of any service, and to learn whether any other intra-abdominal condition requires surgical treatment.

Group 2.—Failures in those cases in which there were real indications for the gastro-enterostomy but in which the results of the operation were unsatisfactory were chiefly due to: (1) imperfect functioning due to a defect in the anastomosis itself or the location of it; (2) an overlooked intra-abdominal disease; and (3) a recurring ulcer.

The first cause produces what may be designated a malfunctioning anastomosis. It is difficult to determine what cases should be placed in this group, since in all those cases of recurring ulceration, particularly at the point of anastomosis, it is uncertain whether malfunction was responsible. Without ulceration at this point, malfunction is extremely rare. For example, in 7000 cases of gastro-enterostomy for peptic ulcer in the Mayo Clinic it was found necessary to disconnect the anastomosis in only five cases because of malfunction alone. The reason for the rarity of the malfunction (excluding the unnecessary gastro-enterostomy) is that proper performance of the operation on adequate indications gives satisfactory relief of ulcer symptoms in 90 per cent. of the cases, and in the majority of the remainder the symptoms are mild, of short duration, and easily controlled by simple measures since they are usually the result of dietary indiscretions or careless habits of living. It becomes necessary to disconnect the anastomosis in cases of malfunction only when the symptoms are not relieved by the gastro-enterostomy and new symptoms have developed as a direct result of this malfunction. The latter is generally due to some technical defect in the performance of the operation, or judgment in selecting the type of operation.

The important points in the technic of gastro-enterostomy have been so frequently described that it is only necessary to emphasize the fact that by far the most common cause of the occasional disappointing results from gastro-enterostomy is inadequate drainage. This may be due to the site chosen for the anastomosis, if it is too near the lesser curvature of the

stomach, too close to the pylorus, or so distant from the pylorus as to create, in a large stomach, an atonic segment between anastomosis and pylorus, resulting in gastric retention. Such cases have been met with. Or, the opening may be too small, either because it was made so at operation or because of contraction due to poor functioning and disuse. The proximal loop of the jejunum may be too long, leading to retention of its contents and regurgitation of bile, or it may be so short as to rotate the anastomosis with sufficient kinking of one or both loops to interfere with gastric motility or drainage. Extensive raw surfaces following the division of adhesions between the first portion of the jejunum and mesocolon may be responsible for later malfunction due to bands of adhesions deforming one or the other of the loops.

Although there seemed to be real indications for gastro-enterostomy in this group, the result may have been unsatisfactory because some other type of operation would have been preferable. There is, however, little evidence in this series to show that, when the anastomosis was functioning properly and there was no recurrence of ulceration, any other type of operation would have been more effective in controlling the symptoms. It is not within the compass of this paper to discuss all the facts relative to this point. It should be repeated, however, that in gastric ulcer, gastro-enterostomy alone should not be depended on to relieve symptoms permanently, or to prevent subsequent complications, but that radical removal of the ulcer, either by excision or by partial gastrectomy, may be the method of choice. For the uncomplicated duodenal ulcer, there is as yet no definite evidence that any other type of operation, in the great majority of cases, gives better end-results than gastro-enterostomy. Partial gastrectomy for chronic duodenal ulcer is comparatively simple and safe, but the end-results cannot as yet be foretold, and an attempt to establish such a radical procedure for such a small and benign lesion may well be postponed until more proof is available that it is warranted. The very great advantages of gastro-enterostomy over these radical procedures are that it is not a mutilating operation, and that by disconnecting the anastomosis the gastro-intestinal tract can be restored to normal. It may be that partial gastrectomy would have been preferable to gastro-enterostomy in the small number of cases in which the latter operation failed to relieve the symptoms completely but there is no way of selecting such cases. For the bleeding type of duodenal ulcer, excision of the ulcer and gastro-enterostomy or gastroduodenostomy are, of course, preferable to gastro-enterostomy alone.

A secondary operation is indicated in this group when it can be shown that the anastomosis is not functioning properly, or when it is inadequate to control symptoms satisfactorily and permit complete and permanent healing of the original lesion. If the patient has not already done so, he should be advised to follow a most careful dietary regimen long enough to determine whether it will cause sufficient amelioration of symptoms to obviate further surgical intervention.

When there are recurrence and persistence of symptoms, they may be due to disease elsewhere in the abdomen, so that the importance of a painstaking

and routine exploration cannot be too often or too strongly emphasized. The fact that a chronic duodenal ulcer has been found does not imply that there may not also be a gastric ulcer, a diseased gall-bladder, a large spleen, or intestinal or pelvic disease, any one of which may explain the failure of the gastro-enterostomy to relieve all symptoms.

The final and most important cause of failure of the gastro-enterostomy in this group of cases is the reactivation of the original ulcer or the occurrence of a new ulcer in the stoma, stomach, duodenum, or jejunum. The total percentage of such recurrences is under 5 per cent. When such a recurrence is intractable to medical management, secondary operation is advisable. Stomatal ulcers occur in about 2 per cent. of cases after operation for peptic ulcer. In the Mayo Clinic, ulcer at or near the anastomosis has developed in 1.44 per cent. of the cases following gastro-enterostomy for chronic peptic ulcer (1.37 per cent. following gastro-enterostomy for duodenal ulcer, and 0.07 per cent. following gastro-enterostomy for gastric ulcer).

The cause of stomatal ulcers is still an enigma since control of all the factors supposed to be involved in the production of ulcer does not prevent them entirely. Since only about 2 per cent. of patients with ulcer develop such secondary ulcerations, it can only be concluded that such patients are abnormally susceptible to ulcers, and that the cause of the original ulcer still exists. As will be pointed out later, they require radical surgical measures. Recurrence of ulcer can be kept at a minimum by a carefully performed operation, the subsequent eradication of all foci of infection, and the avoidance of gross indiscretions in diet or habits of living.

The symptoms of recurring ulcer are like those of the original ulcer, except that those in the stoma have certain characteristic features. The most important of these is the severity of the pain associated with the taking of food, its location to the left of the median line and at a considerably lower level than with ulcer of the stomach or duodenum. The stomatal ulcer is more resistant to treatment, and the temporary relief which often follows medical treatment of primary ulcer is not often obtained. When such relief is experienced, the prompt reappearance of pain on return to a normal diet is of marked diagnostic significance. The stomatal ulcer shows a marked tendency to penetrate into neighboring structures, so that colic fistulas are not uncommon in long-standing cases. The incidence of hemorrhage is higher in cases of gastrojejunal ulcer than in cases of primary ulcer.

Operation is indicated for the recurring ulcer more often than for the original ulcer: it offers the best and safest prospect of cure. A thorough trial with an approved medical regimen may first be carried out, but it is even less likely to succeed than with the original ulcer and should, therefore, not be prolonged.

Technic.—The essential feature in operating for any type of recurring ulcer is a careful and routine abdominal exploration. This should be done in every case unless conditions prohibit it. The exploration will include mobilization and inspection of the anastomosis, examination of the stomach, the

duodenum, and particularly of the pylorus to determine whether it can be depended on to function satisfactorily, and also examination of the gall-bladder, pancreas, appendix, spleen, and pelvis, since disease in some organ other than the stomach or duodenum may, at least partly, explain the original symptoms. The exploration will enable the surgeon to decide what surgical procedure is necessary. The more common of these are: (1) disconnection of the anastomosis followed by pyloroplasty or some type of gastroduodenostomy; (2) disconnection of the anastomosis alone; (3) disconnection of the anastomosis with cholecystectomy or appendectomy or both; (4) disconnection of the anastomosis followed by a second gastro-enterostomy; and (5) disconnection of the anastomosis followed by partial gastrectomy.

These different procedures vary from those of comparative simplicity to those of extreme difficulty. Disconnection of an uncomplicated anastomosis is performed as follows: the incision is preferably placed to the left of the former incision or incisions (in this series 35 per cent. of the patients had been operated on more than once). The stomach, colon, omentum, and pylorus are first freed and the anastomosis mobilized. The most important step is freeing the mesocolon, which is usually intimately attached at the anastomosis. The safest and simplest method of freeing this is to begin the dissection on the posterior aspect of the stoma, and when the posterior wall of the stomach is exposed to insert the finger between the mesocolon and the stomach, by finger dissection to loosen the mesocolon from the stomach, and with the finger as a guide to dissect it free from its attachments. The segment of stomach to which the intestine is attached can then be drawn down through the large opening in the mesocolon, a gauze pad placed behind the anastomosis, and straight rubber-covered clamps placed on this segment of stomach and on the two limbs of the jejunal loop, each clamp being about 8–10 cm. from the anastomosis. While a finger supports and identifies the line of anastomosis posteriorly, heavy scissors are used to divide the anastomosis, the line of division being slightly on the stomach side. The opening in the jejunum is then closed in a transverse direction by two rows of continuous chromic catgut, reinforced by interrupted sutures of the same material. Encroachment on the lumen of the jejunum is not dangerous if the opening is closed in this transverse direction. The opening in the stomach is closed by continuous chromic gut, and the defect in the mesocolon repaired by a continuous fine catgut suture.

While such an operation is usually relatively simple and safe, disconnection of the anastomosis in a complicated case in which resection of the stomach is also necessary is always prolonged, often difficult, and the patient is frequently in poor condition. The most serious surgical problem is the gastrojejunal ulcer which has perforated into the colon, particularly when the anastomosis has been made on a very short proximal loop, and when the pylorus, because of previous operation or scarring from ulceration, cannot be depended on to carry on its function normally. In such cases a number of major surgical procedures may be necessary. Disconnection of the anas-

tomosis is difficult because the extensive inflammatory products have fixed the anastomosis and do not permit ready mobilization. The colon should first be dissected free, the opening closed, and the site of the closure covered with omentum. I have found it advisable, in disconnecting the anastomosis in which ulceration has occurred, first to divide the stomach on a line about 2.5 cm. or more from the anastomosis. This permits inspection of the anastomosis and a more precise excision of the ulcer. Before the jejunum is closed, the edges of the stomach still attached to the jejunum are removed. If it has not been possible to ascertain the patency of the pylorus, it may be examined digitally through the opening in the stomach. If a resection of the stomach is indicated (and it is the operation of choice in recurring ulcer, whatever its situation), the opening in the stomach is closed with a running suture of chromic catgut. This prevents soiling. The pyloric end of the stomach is then mobilized and, if the duodenum is scarred by previous ulceration or operation, the division, between crushing clamps, is made far enough above the pylorus to permit of an easy and safe closure of the stump. The omental attachments along the lesser and greater curves are divided to a point high enough on the stomach to minimize the possibility of subsequent ulceration. All vessels are tied, a rubber-covered clamp is placed, with the least possible pressure, on the stomach about 3.75 cm. above the line of resection, and the stomach turned to the left. The jejunum is then brought up in front of the colon and approximated to the stomach so that the proximal jejunum, about 35 cm. from the duodenojejunal angle, is at the lesser curve. An antecolic anastomosis is often preferable in such cases because the resection is extensive and a retrocolic anastomosis must be made in a field of adhesions, with the danger of subsequent adhesions crippling the anastomosis. The first row of chromic catgut is placed before the stomach is cut away, and the anastomosis completed in the usual manner. A small entero-anastomosis should be added to this type of anastomosis, the union being made at a level with the duodenojejunal angle. The segment of stomach, the entire anastomosis, and the entero-anastomosis will fall well to the left of the median line, and perfect drainage is secured with no danger of retrograde distention of the proximal loop. In certain cases, if the closure of the pyloric stump has not been satisfactory, or if it is desirable to keep the entire field of operation as immobile as possible, a catheter may be sutured into the distal loop of the jejunum for a week or ten days for feeding purposes. Similarly, when the closure of the transverse colon has been difficult and perhaps imperfect, a small cæcostomy may be made to prevent distention of the colon. Such an operation is, of course, formidable, but if the pre-operative and post-operative management is all that it should be and the operation properly performed, the results will be excellent.

Patients with secondary ulcers should first be placed in the hospital under the care of the clinician. Hospitalization enables the clinician to acquire a better understanding of the surgical problems involved in the more complicated cases, and more important, enables him to estimate the hazards of opera-

tion and thereby to bring the patient to the point where operation can be carried out with the maximal safety. Such preparation consists chiefly of transfusions, gastric lavage, the administration of sodium chlorid and glucose solutions, a bland diet, and the control of the toxæmia associated with obstruction. The latter is a most striking advance in the management of obstruction, and the value of McVicar's recent report on this management in thirty such cases can hardly be over-emphasized from a surgical point of view. When the responsibility of the preparation of patients with serious gastric disorders is really assumed by the gastro-enterologist not only with regard to the medical aspects of the case, but the results of the operation, it immeasurably raises the factor of safety and adds to the prospect of good post-operative results. Such coöperation made possible the report of a recent series of eighty partial gastrectomies (including thirty-six for cancer, nine for gastro-jejunal ulcer, and twenty-eight for gastric ulcer) with but one death.[1]

The problems of gastro-enterostomy, therefore, should be limited, at least before the American Surgical Association, to those cases in which the operation was clearly indicated, but failed to afford permanent relief from the symptoms. Fortunately such cases are not common, and it is equally fortunate that the simple mechanical principles on which the operation is based permit the restoration of the stomach and upper intestinal tract to the condition existing before the gastro-enterostomy was performed. A recent writer of the European school of radical gastric surgery claims that gastro-enterostomy is a disease. If it is a disease, it at least has the virtues of being both preventable and curable.

REFERENCE

[1] Balfour, D. C.: The Value of Coöperation between Internist and Surgeon in the Management of Complicated Gastric Conditions, with some remarks on Partial Gastrectomy. Jour. Am. Med. Assn., 1925, vol. lxxxiv, pp. 876–879.

PRIMARY CARCINOMA OF THE SMALL INTESTINE IN AN OCTOGENARIAN*

By Alexander Primrose, C.B., M.B., C.M.
of Toronto, Ontario
professor of clinical surgery in the university of toronto

Tumors of the small bowel may be innocent or malignant. The innocent tumors met with include adenoma, fibroma, lipoma, and myoma. The malignant growths are cancer and sarcoma, both of which are rare manifestations in the small intestine. It is interesting to observe that sarcoma when it does manifest itself in the intestine is much more common in the small bowel than in the large. Thus Corner and Fairbank collected from the literature 103 cases of sarcoma of the intestine; of these 65 (63 per cent.) were present in the small bowel, the largest number being in the ileum, and 38 in the large bowel (37 per cent.). The reverse is true of cancer. Only three per cent. of carcinomata of the intestines occurs in the small bowel (Ewing, Johnston, Hinz).

The age incidence for sarcoma of the small intestine shows the greatest frequency between thirty and forty years of age (Corner and Fairbank), while the average age for cancer in this locality is forty-six and one-half years (Ewing). On the other hand, Telling reports a spindle-cell sarcoma in a child three and one-half years old and Duncan records a scirrhous cancer at the same age (three and one-half years). As far as I am aware, primary carcinoma of the small intestine has not hitherto been recorded in an octogenarian.

The case is as follows: B. R., *æt.* eighty, male, was seen in consultation January 14, 1924. Ten days previously he had celebrated his eightieth birthday. For some months he had experienced increasing difficulty in getting a movement of the bowels. He suffered abdominal pain and there was some distention. A barium enema followed by X-ray examination revealed a diverticulitis of the sigmoid flexure of the colon; there was a marked degree of constriction of the lumen with some diverticuli in the picture. There was, however, no very great degree of obstruction at this point. The writer had removed this patient's prostate five years previously, and he had some cystitis. This fact, in addition to his extreme age, caused us to temporize, recognizing the conditions as constituting a bad risk for operation. One element in his favor was the circumstance that he was a man of remarkably good physique and had enjoyed excellent health for many years.

February 27, 1924, obstruction became more pronounced with increased pain and vomiting. He had lost weight. Operation had become imperative. The abdomen was opened under gas anæsthesia when one was surprised to find the small bowel distended while the large bowel was of normal size and appearance. The distended loops of small bowel were allowed to protrude freely from a large abdominal incision, with the minimum amount of traumatism. A constriction at once became evident in the ileum eight inches proximal to the ileo-cæcal juncture. A tumor was felt at this point and the wall of the bowel above, in its immediate neighborhood, was thickened as was also the adjacent

* Read before the American Surgical Association, May 4, 1925.

mesentery. There was no visible or palpable lymph glandular involvement. Without disturbing the protruded coils of intestine an immediate resection was performed, including the thickened portion of bowel above the tumor, and an end-to-end anastomosis established. The intestine was then replaced with great care within the abdomen and the incision closed without drainage. The patient made an uninterrupted recovery and now in his eighty-second year is completely free from his former trouble.

The pathologist's report, by Dr. W. L. Robinson, is as follows: Gross Specimen (Fig. 1): consists of a piece of bowel 8 cm. in length and about 4 cm. in diameter. Attached to this is a bit of the mesentery, no longitudinal striæ can be seen. On opening the gut at about the central portion projecting into the lumen is seen a tumor mass about 2 cm. in diameter. It is pinkish-white in color, fairly firm in consistency, and does not protrude far into the gut lumen. At its base is some white scar tissue and the gut seems to be contracted by fibrous tissue at this point. On section this tumor mass is yellowish-white in color and homogeneous in appearance and fairly soft throughout.

Microscopic Findings.—(Figs. 2 and 3.) Section of this tumor mass shows it to be composed of cords and masses of atypical epithelial cells which are growing in the bowel wall and invading deeply through the muscular coat. These epithelial cells are all of about the same size and shape. They have a round somewhat reticulated nucleus and a moderate amount of pinkish staining cytoplasm and in various places is seen a somewhat pseudo-glandular arrangement. No mitotic figures are present. The cells are supported in a fibrous tissue stroma which in places is quite considerable in amount. Obviously it is a tumor which is only locally malignant.

Section taken from the gut higher up shows the mucous coat to be considerably degenerated and throughout there is a moderate amount of fibrous tissue, infiltrated with many polymorphonuclear cells and lymphocytes. The muscular coat seems somewhat thickened and its fibrous tissue is increased in amount. In the subserous coat fibrous tissue proliferation is marked and here in various places are seen focal aggregations of lymphocytes.

The pathological diagnosis was that of embryoma ("benign carcinoma" of the intestine) with acute and chronic enteritis.

The development of cancer in the small intestine would seem, in many instances to bear a direct relationship to the development of intestinal polypi, and may even be a local malignant manifestation in a general polyposis. On the other hand, adeno-carcinoma may arise in the small bowel quite apart from the development of polypi; such tumors may be slow in growth, but eventually they tend to ulcerate and to develop scirrhous stricture. They metastasize in the mesenteric glands, the liver, the lungs and elsewhere.

The type of tumor found in the present instance was only locally malignant. It belongs to the group which has been variously described as "carcinoid," "embryoma" and "basal-cell carcinoma." These tumors are frequently multiple: they usually form more or less spherical masses projecting from a wide base into the lumen of the bowel. The surface is smooth and covered with mucosa. They invade the muscularis and subserous tissues. They do not tend to ulcerate, but may be accompanied by a scirrhous formation which is capable of producing a ring stricture of the bowel. The dilated bowel above usually shows hypertrophy of the muscular coat with fibrosis. These conditions were present in the case reported in this paper. In a case reported by Judd the entire small intestine proximal to a growth in the ileum was enormously distended, very thick walled, injected and œdematous.

An attempt has been made by Johnston to collate the clinical phenomena

produced by such a tumor causing obstruction in the small intestine. Visible peristalsis is commonly present, indicating definite evidence of mechanical obstruction, and when the stricture exists in the lower part of the ileum, four or five coils of distended bowel will produce a "ladder" arrangement as they lie, side by side, running transversely across the abdomen. Shifting dulness is exhibited as the position of the patient is changed, due to the fluid content of the distended bowel above the obstruction. The symptoms include pain, vomiting and often rapid emaciation. There is frequently much "gurgling" noted both by the patient and the doctor. Blood in the stools is rarely met with, but is said to be most common in the stenosing form. The existence of a tumor is rarely discovered on examining the patient. Lahey, however, reports two cases in each of which was a palpable freely movable tumor. Hinz has also reported two such palpable tumors. When the tumor exists in the jejunum the clinical picture has often simulated pyloric obstruction leading to an erroneous diagnosis of a lesion in the stomach or duodenum.

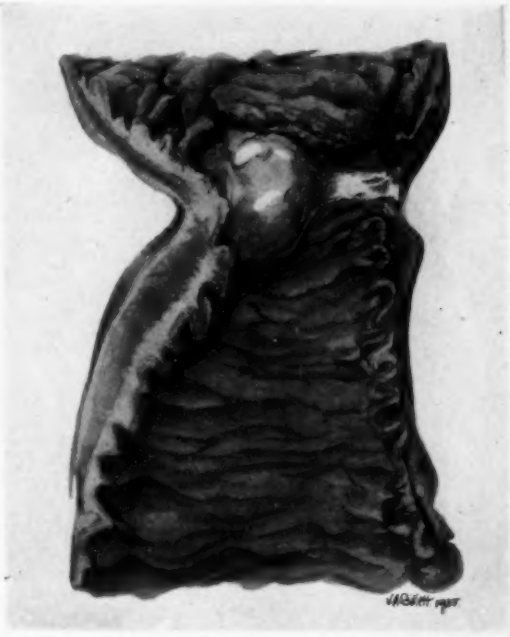


FIG. 1.—Primary carcinoma, small intestine. (Ileum.)

Having regard to the nature of this growth—a smooth, rounded, slow-growing tumor projecting into the lumen—one is not surprised to find that intussusception has been produced in many of the reported cases. In the more malignant type of adeno-carcinoma perforation may occur and a fistulous communication may be established between neighboring coils of intestine. Johnston refers to water color drawings of three cases of carcinoma of the jejunum made by Sir Robert Carswell in Paris, between 1821–1831. In all of these perforation had occurred. One of them shows a fistulous communication between the jejunum at the seat of growth and the transverse colon.

The carcinoid or embryonal tumors, occurring in the small bowel, form an interesting group of new growths which were first described, as specific entities in 1888 by Lubarsch. The histological findings in all cases are sufficiently distinctive. The cells are spherical or polygonal in shape and are massed together with a considerable amount of interstitial fibrous tissue surrounding the cell groups. There may be some traces of alveolar formation. Many writers believe these tumors are similar in character to the

growths which are described as "primary carcinoma of the appendix." (Aschoff, Adami and McCrae, etc.) Not only is this true of the histological structure, but the gross appearances are very similar. Thus in the case described in this paper the writer at the time of operation remarked on the fact that the tumor, with its smooth surface and firm consistence, resembled the gross appearance of growths of the same type met with in the appendix. Bunting observed the close resemblance of these tumors to the basal-cell epitheliomata, which have been carefully studied by Krompecher, multiple tumors occurring chiefly in the scalp, which do not tend to metastasize and which have been considered as arising from the hair follicles or sebaceous glands. Ewing has discussed the views which have been promulgated as to the origin of these tumors, suggesting that they may represent heterotopic intestinal mucosa, heterotopic Brunner's glands or heterotopic pancreatic gland tissue: the cells may exactly reproduce the islands of Langerhans of the pancreas.

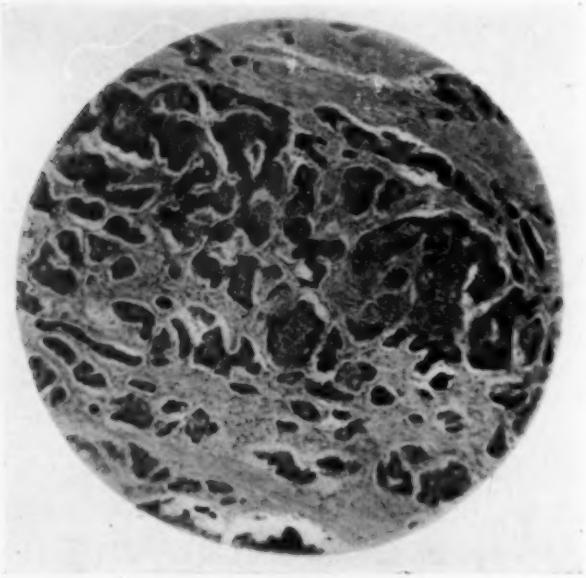


FIG. 2.—Microscopic findings in the tumor described in the text. (X 250.)

These tumors run a benign course: they grow slowly and seldom ulcerate on the surface, they do not tend to form metastases and do not recur after removal. The only exception one had found in the literature is a case recorded by Ransom. A woman fifty years of age had a rounded polypoid growth projecting into the lumen of the ileum six inches from the ileocæcal valve. She had numerous metastases in the liver. The histology of this growth, which is described in detail and figured in its microscopic structure in Ransom's paper, would appear to be identical with the tumors described by Bunting, Lubarsch and others. The occurrence of metastasis therefore must be considered as a very remote possibility.

The carcinoid tumors (often multiple) of the small bowel would appear to be analogous with the so-called primary carcinoma of the appendix. The clinical course and the histological picture would seem to establish this fact. In a paper which the writer published a few years ago, attention was called to the somewhat remarkable co-existence of tubercle and the growths in question in recorded cases. In that paper one described two cases of primary carcinoma of the appendix in sisters both of whom suffered from tuberculosis:

the one from pulmonary tuberculosis, the other had a primary cancer of the appendix adherent to a tuberculous fallopian tube. This relationship to tuberculosis is not only true of the appendix tumor, but is found as a common event in the recorded cases of the multiple tumors of the small intestine. Curiously enough the gross appearances often simulate tubercle. Thus Venot and Parcelier refer to two cases in the literature reported by Trixier and Wrede, respectively, in which tumors of the small bowel were regarded as carcinoma at operation but which proved by microscopic examination to be tuberculous. In a third case reported by Chalier the reverse was true: multiple tumors in the small bowel (and in addition one in the cæcum and another in the transverse colon) were believed to be tuberculous both at operation and at autopsy; but subsequently the histological structure proved to be colloid cancer. Lubarsch suggests that tuberculous infection, even as a local trauma, may lead to the development of cancer. Hinz reports two cases of carcinoma of the small bowel accompanied by tuberculosis. Milner in investigating fourteen cases of primary cancer of the appendix is struck by the resemblance to tuberculous cases and concludes that the tumors are the product of a chronic hyperplastic inflammation, chiefly a hyperplastic lymphangitis, and their parenchymal cells are endothelium and not epithelium. Then there is the significant case reported by Balfour and Watson of tuberculosis of the Fallopian tube in which the extreme ends, which were free from tubercle, showed marked hyperplasia of the epithelium with extension into the muscular wall, presenting a histological picture of carcinoma. Oberndorfer (quoted by Bunting) found four nodules in the middle of the ileum of a woman who died of chronic tuberculosis. "The nodules showed a rather fibrous stroma and alveoli filled with polymorphous cells, but as the author could find no definite connection with the intestinal epithelium, he regarded the tumors as lymphatic endothelial carcinomata."

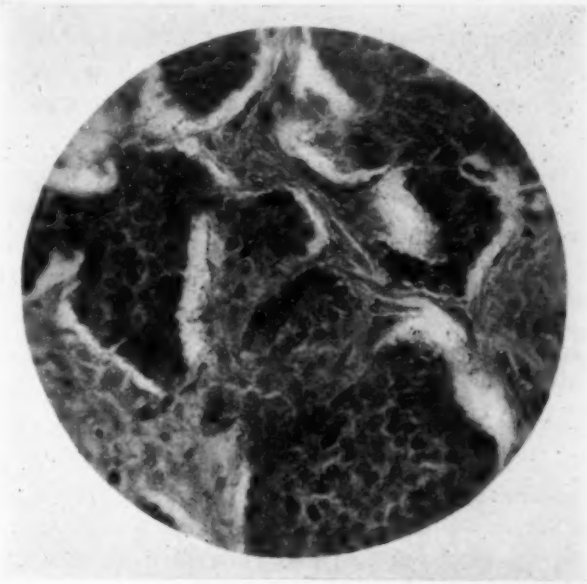


FIG. 3.—Microscopic findings in the tumor described in the text. (X 400.)

The relationship of tuberculosis to cancer has frequently been the subject of speculative enquiry. Rokitansky many years ago (1846) considered there

was an antagonism between tuberculosis and cancer. In support of his theory he noted the fact that in organs where tuberculosis commonly occurred, cancer was rarely found and *vice versa*. Thus in the lungs tubercle is common and cancer rare: in the stomach cancer is of frequent occurrence and tubercle seldom found, and so he contrasts the occurrence of these diseases in the ovary, the salivary glands, the œsophagus, the rectum and the ileum. In each of these organs one or other disease is common and the other rare. In 1915, Shattock and Dudgeon confuted this theory. They recognize that while the co-existence of tuberculosis and carcinoma is not a common one, yet the two diseases may be present simultaneously in different organs or they may co-exist in the same organ. They refer to a specimen in the Royal College of Surgeons Museum in which metastatic carcinoma occurred in lungs which were tuberculous. In their paper they reproduce a drawing showing the microscopic section of a tuberculosis of the testis distributed in a spheroidal-cell carcinomatous growth. They quote Roger Williams as having collected from the literature instances in which the two diseases were present in the same locality. This list includes the stomach, uterus, mamma, liver, large intestine, rectum, small intestine, larynx, lung and œsophagus. Nevertheless the rarity of this conjunction of the two diseases is shown by Roger Williams, who in 136 cancer necropsies found only two cases in which both diseases existed together. Oertel who discusses this subject at length concludes that the two diseases do not possess specific antagonistic qualities.

While tuberculosis is seldom associated with malignant forms of cancer, it would appear to be a much more frequent accompaniment of the so-called carcinoid tumor of the small bowel and of the appendix. The genesis of this interesting tumor is still obscure. From a study of the cases in literature the author is inclined to believe that the simultaneous existence of tubercle and the carcinoid tumor is more than a mere coincidence and that possibly tuberculosis may in many instances, at any rate, play an important part in the production of the tumor formation.

BIBLIOGRAPHY

Adami and McCrae: A Text-book of Pathology, 1914, p. 658.

Aschoff, L.: Pathologische Anatomie, 1911, Bd. ii, p. 708.

Barbour, A. H. F., and Watson, B. P.: Tuberculous Pyosalpinx. Journal of Obstetrics and Gynæcology of the British Empire, September, 1911.

Bunting, C. H.: Multiple Primary Carcinoma of the Ileum. Johns Hopkins Hospital Bulletin, vol. xv, 1904, p. 389.

Corner, E. M., and Fairbank, H. A. T.: Sarcomata of the Alimentary Canal. Trans. Pathological Society, vol. lvi, 1905, p. 20.

Duncan, A. J.: Scirrhus of Abdominal Organs in a Young Child. Edinburgh Medical Journal, vol. xxxi, 1886, p. 1127.

Ewing, James: Neoplastic Diseases, 1919, p. 641.

Hinz, R.: Ueber den primären Dünndarmkrebs. Archiv für Klinische Chirurgie, vol. xcix, 1912, p. 305.

Johnson, Raymond: Carcinoma of the Jejunum and Ileum. British Journal of Surgery, vol. ix, 1922, p. 422.

Judd, E. S.: Carcinoma of the Small Intestine. Collected Papers of the Mayo Clinic, vol. x, 1918, p. 203.

Krompecher, E.: Ueber die Basalzellentumoren der Zylinderepithelschleimhäute mit besonderer Berücksichtigung der "Karzinoide" des Darms. Ziegler's Beitrage Z. path. Anatomie, vol. lxv, 1919, p. 79.

Lahey, F. H.: Carcinoma of the Small Intestine. ANNALS OF SURGERY, vol. lxii, 1915, p. 428.

Lubarsch, Otto: Ueber den primären Krebs des Ileum nebst Bemerkunken über das gleichzeitige Vorkommen von Krebs und Tuberculose. Virchow's Archiv, 1888, Bd. cxi, S. 281.

Milner, R.: Die Entzündlichen Pseudo-Kerzinome des Wurmfortsatzes. Dentische medicinische Wochenschrift, No. 25, 1910, vol. xxxvi, p. 1191.

Oertel, H.: On the Relative Local Influence of Co-existing Tuberculous Inflammation and Cancer in the Lung. Journal of Medical Research, Boston, vol. xxv, 1911–12, p. 503.

Ransom, W. B.: Primary Carcinoma of the Ileum. Lancet, 1890, vol. ii, p. 1020.

Rokitansky, Carl: Pathological Anatomy. English Edition, vol. i, p. 237.

Shattock, S. G., and Dudgeon, L. S.: Wound Inoculation in Carcinoma. Trans. Royal Society of Medicine, vol. viii, Pt. 3, 1915, p. 33.

Telling, W. M.: Primary Sarcoma of Small Intestine Causing Unusual Symptoms. Trans. Royal Society of Medicine, vol. xiii, 1919, p. 152.

Venot et Parcelier: La Carcinome primitif du jéjuno-iléon. Revue de Chirurgie, vol. xlvii, 1913, p. 678, vol. xlviii, 1913, p. 436.

INTUSSUSCEPTION IN ADULTS DUE TO THE INVAGINATION OF A MECKEL'S DIVERTICULUM

By William E. Lower, M.D.

of Cleveland, Ohio

from the cleveland clinic

The interest which is always attached to pathological conditions which originate in a Meckel's diverticulum, together with the comparatively rare occurrence of an enteric intussusception due to inversion of this anomalous structure, has led me to report the following two cases which have occurred in my own surgical practice, one many years ago, and the second within the current year.

Case I.—The first of these patients was a man, forty-three years of age, who for a year had had attacks of pain in the upper abdomen with some vomiting which were thought to be due to indigestion. These attacks had been of moderate severity until ten days before I saw him in consultation, when he had a severe attack of pain and vomiting with some abdominal distention. This attack lasted from two to three hours, the severe pain continuing throughout that period. As soon as the attack passed, however, the patient went back to work. Two days later vomiting began again and lasted for three hours. Five days later another attack somewhat less severe than the preceding, lasted for four hours; and again five days later the final attack occurred which was so severe that the patient had to be carried home and a physician called, severe pain lasting for two hours. Examination revealed that there was some distention and an indefinite mass in the right upper abdomen. There was not much rigidity and only a slight elevation of temperature. The attacks simulated hepatic colic but the fullness in the right side was not like that which would be caused by a distended gall-bladder. An exploratory operation was advised; the abdomen was opened by a right rectus incision which disclosed an ileocæcal intussusception about one and one-half feet in length, about four feet of the intestine being involved. It was impossible to reduce the intussusception completely by manipulation. It was therefore resected and an anastomosis of the ileum to the transverse colon was made. Dissection of the resected portion of the intestine showed that in addition to the ileocæcal intussusception there was an enteric intussusception about six inches in length and that the cause of the intussusception was an inverted Meckel's diverticulum. The patient made a good recovery from the operation and has remained entirely well.

Case II.—The second case was a woman, forty-four years of age, who had had repeated attacks of colic for six months before I saw her. The attacks started in the epigastrium and radiated to the appendiceal region. The last attack began about a week before she entered the hospital. She never had any vomiting until the night before operation. The pain was more or less rhythmical, spasmodic recurrences coming on about every five minutes. The patient was severely constipated and had considerable meteorism. The abdomen showed no rigidity, but was slightly distended and had a doughy consistency. There were no palpable masses and only moderate tenderness over the abdomen, especially over the right kidney area.

Exploratory operation was performed and an enteric intussusception was found which could not be reduced. Resection was therefore performed with end-to-end anastomosis. The intussusception was approximately fifteen inches in length, involving thirty inches of the intestines, which revealed an inverted Meckel's diverticulum.

As far as I have been able to discover, only 52 clearly defined cases of intussusception due to an inverted Meckel's diverticulum have been reported in the literature. Hertzler and Gibson (1913)[15] collected 45 clearly defined cases with reports of six others which they consider doubtful. To this list should be added six others reported respectively by Fauntleroy,[16] Depisch,[18] Greenwood,[20] Johnson,[19] Hood,[22] and Vickers,[23] and a case reported by Stone,[21] which is of interest, as it probably illustrates the initiation of the process which, if it had continued, would undoubtedly have caused a complete

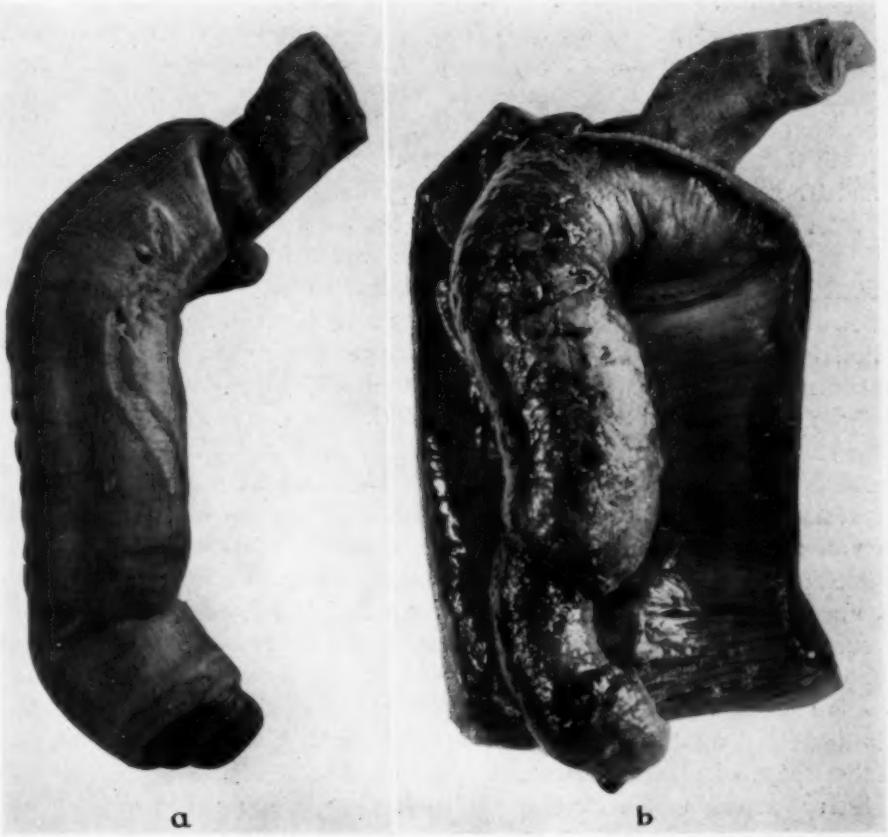


FIG. 1.—a. Gross specimen as removed. b. Specimen opened showing inverted diverticulum.

invagination of the diverticulum with a resultant intussusception. "The walls of the diverticulum were œdematous, as it had been inverted, much as a glove finger may be pushed in." A study of these reported cases brings out the following points which are of primary interest. As would be expected from the more frequent occurrence of Meckel's diverticulum in males, among these 52 cases, it is stated that 34 were in males and 9 in females; 11 were between 10 and 20 years of age, 21 under 10; the total range of age was from 7 months to 39 years, the average age being 13 years. My own cases, therefore, are older than any thus far reported. This point is of primary interest, as it

indicates that in contradistinction to the usual incidence of intussusception, intussusception due to an inverted Meckel's diverticulum is in general a condition pertaining to older children or young adults and that it may be expected in more advanced years and there is no reason why it may not occur at any age.

The points in the symptomatology which have impressed nearly all of the reporters are (1), the repeated attacks of partial obstruction before the culminating attack which led to surgical intervention, in some cases these repeated attacks being sufficiently mild and extending over a period of time to suggest chronicity; (2) the absence of blood in the stools; (3) the frequent lack of a palpable tumor; (4) the lack of local tenderness. All of these points are of prime importance in establishing the differential diagnosis between Meckel's diverticulum and conditions which might readily be confused therewith. As one would expect, the differentiation from appendicitis and from cholelithiasis is of primary importance.

Halstead [8] calls attention to what he considers to be a characteristic configuration of the abdomen, "that of an inverted cone, this being due to obstruction of the upper part of the intestinal tract. The absence of distention of the flanks is conspicuous during the early hours of the attack." Attention is called, also, to the coincident appearance in many cases of some abnormality of the umbilical scar. This, however, does not appear to me to be of any importance in the type of cases which we are considering here. When the remnant of the emphalomesenteric duct remains patent and attached to the umbilicus, intussuscepton through the umbilical opening may readily occur. Intussusception of this type, however, would occur most frequently in young children. If the diverticulum remains attached by a fibre or band to the umbilicus its invagination could hardly occur, although in such cases, as will be noted later, inflammation of the mucous membrane and its opening might cause a partial inversion of its serous lining with a resultant intussusception. Excepting when the diverticulum is non-adherent to neighboring structures, or is not attached to the umbilicus by bands or a fibrous cord, this type of intussusception, therefore, need not be considered, although in such cases other types of obstruction may readily occur such as volvulus or complete obstruction due to the catching or binding of the intestine about or under one of these attachments. I have had several such cases.

The manner in which the process of invagination of the diverticulum is initiated has been discussed by different writers, DeQuervain believes that it is due to a type of suction produced by the rapid passage of the contents of the small intestines past its opening whereby a partial vacuum is produced within the diverticulum. Apparently this view is shared by none of the other writers among whom the consensus of opinion seems to be that invagination is due either to peristalsis of the diverticular walls in an effort to expel its contents or, and this is by far the most frequently accepted opinion, to an inflammatory process about the opening of the diverticulum which produces thickening of its walls, this process gradually extending so that the mucous

membrane at the opening is slowly pushed along with the peristaltic action and the contents of the intestine. Sometimes the inflammatory process may produce a polyp-like structure which increases the propulsive action whereby the serous lining of the diverticulum is pushed farther and farther into the intestinal stream. The process might be compared to a continued tugging on a partially attached silk or wool lining of a kid glove whereby at first the lining and finally the finger of the glove would become inverted. As the process continues the inverting diverticulum is projected farther and farther into the intestine and the resultant partial obstruction initiates the process of invagination of the intestinal wall itself. The apparent chronicity of this type of obstruction is well explained, as has been suggested by Corner,[9] by the fact that since the obstructing process is unilateral, the stream would at first be only partially diverted diagonally rather than directly obstructed.

When one considers that, as is estimated, two per cent. of all individuals have a Meckel's diverticulum; and that as a result of its proximity to the ileocæcal valve any hesitation of the fœcal stream at that valve might easily cause particles of food to become lodged within it, the surprising fact would seem to be that there are not more catastrophes due to some pathological condition of this structure. We certainly should at least suspect the presence of a diverticulum and possibly of a beginning intussusception in cases which present the type of symptoms listed above, especially in young adults; or as is illustrated by my own cases, in older patients who have had recurrent attacks of right-sided abdominal distress, with or without bloody stools or diarrhœa; with or without a palpable tumor; with or without tenderness to the right of the umbilicus. In such a case, if no other cause of the condition can be demonstrated, the presence of a Meckel's diverticulum should be suspected and an exploratory operation performed, for provided it is present the catastrophe of intussusception may occur at any time. If it is not present, no more harm is done by the exploratory operation than is done by the removal of the chronic appendix because of the presence of the train of symptoms which suggest a chronic appendicitis with the ever-present danger in that case also, of an acute catastrophe. Moreover, just as the appendix is routinely removed in the course of an abdominal operation in order that the source of danger for the future may be obviated, it would certainly appear well to consider whether or not one should look for a diverticulum in those cases in which an exploratory operation is performed for suspected appendicitis and the appendix is found to be normal.

The discovery of these rare conditions always brings a thrill to the surgeon. The thrill, however, is of no account unless it induces him to add his contribution to an interpretation of the significance of the condition. It is because of this that I have offered this note regarding this apparently unusual condition, which nevertheless, suggests an explanation of some of our most difficult cases—those which present vague, uncertain symptoms which may be due to a large variety of causes as well as to some of the acute catastrophes,

especially in young adults. While it is not advisable always to search for the unusual condition, nevertheless, the possibility of an unusual condition should always be borne in mind.

BIBLIOGRAPHY

[1] Wallett, Edgar: An Account of Some of the More Interesting Specimens Recently Added to the Museum. St. Bartholomews Hosp. Rep., 1891, vol. xxvii, pp. 169–172.

[2] Adams, James: Ileo-colic Intussusception Caused by an Inverted Meckel's Diverticulum. Trans. Path. Soc., London, 1892, vol. xliii, pp. 75–76.

[3] Peters: Invaginated Meckel's Diverticulum. Rep. of Tor. Path. Soc., Oct. 30, 1897; Canadian Pract., 1897, vol. xxii, pp. 922–923.

[4] Küttner, H.: Ileus durch Intussusception eines Meckel'schen Divertikels. Beitrag. z. klin. Chir., 1898, vol. iii, pp. 289–298.

[5] Erdmann, J. F.: Report of a Case of Intussusception Due to a Meckel's Diverticulum. N. Y. Med. Jour., 1898, vol. lxvii, pp. 526–528.

[6] McFarland, J.: Volvulus and Intussusception of Meckel's Diverticulum. Phila. Med. Jour., 1901, vol. vii, pp. 863–864.

[7] Wainwright, J. M.: Intussusception of Meckel's Diverticulum. ANNALS OF SURGERY, 1902, vol. xxxv, pp. 32–35.

[8] Halstead, A. E.: Intestinal Obstruction from Meckel's Diverticulum. ANNALS OF SURGERY, 1902, vol. xv, pp. 471–494.

[9] Corner, E. M.: On the Pathology and Classification of Intussusceptions, with a Résumé of Those Arising from the Appendix Cæci. ANNALS OF SURGERY, 1903, vol. xxxviii, pp. 690–725.

[10] Cheyne, W. Watson: Intussusception of Meckel's Diverticulum. ANNALS OF SURGERY, 1904, vol. xl, pp. 796–804.

[11] Bidwell, L. A.: Intussusception Caused by an Inverted Meckel's Diverticulum; Excision and End-to-end Anastomosis. Lancet, 1907, vol. ii, pp. 682–684.

[12] Gray, H. Tyrell: Some Cases in which Meckel's Diverticulum was Present. Brit. Med. Jour., 1907, vol. ii, pp. 823–826.

[13] Gray, H. Tyrell: Invagination of Meckel's Diverticulum. ANNALS OF SURGERY, 1908, vol. xlviii, pp. 801–820.

[14] Drummond, H.: Inversion of Meckel's Diverticulum. ANNALS OF SURGERY, 1912, vol. lv, pp. 404–415.

[15] Hertzler, A. E., and Gibson, E. T.: Invagination of Meckel's Diverticulum Associated with Intussusception. Report of Cases with a Study of Recorded Cases. Am. J. Med. Sci., 1913, vol. cxlvi, pp. 364–386.

[16] Fauntleroy, A. M.: Report of a Case of Intussusception Caused by a Meckel's Diverticulum. U. S. Nav. Med. Bull., 1916, vol. x, pp. 511–513.

[17] McDonald, A. L.: Meckel's Diverticulum as a Cause of Surgical Lesions. Jour. Lancet, 1918, vol. xxxviii, pp. 259–264.

[18] Depisch, F.: Ein Fall von Invagination eines Meckel'schen Divertikels mit nachfolgender Dünndarminvagination. Wien. klin. Wchnschr., 1921, vol. xxxiv, pp. 240–241.

[19] Johnson, J. A.: Meckel's Diverticulum as an Etiological Factor in Intestinal Obstruction. Report of Three Cases. Minnesota Med., 1923, vol. vi, pp. 479–484.

[20] Greenwood, H. H.: Ileo-colic Intussusception Caused by Meckel's Diverticulum and Simulating Ectopic Gestation. Brit. Med. Jour., 1923, vol. i, pp. 1016–17.

[21] Stone, Eric: Aberrant Gastric Mucosa. Report of Two Cases. An Umbilical Polyp and a Meckel's Diverticulum. Surg., Gyn. Obst., 1923, vol. xxxvii, pp. 51–56.

[22] Hood, U. L.: Case of Intussusception Starting in Large Meckel's Diverticulum. Lancet, 1923, vol. i, p. 1004.

[23] Vickers, W.: Intussusception with Meckel's Diverticulum. M. J. Australia, 1923, vol. i, pp. 699–700.

ANATOMY AND TREATMENT OF REDUCIBLE OBLIQUE INGUINAL HERNIA*

By Ellsworth Eliot, Jr., M.D.
of New York, N.Y.

The unobliterated processus sacciformis which forms the sac of a congenital hernia almost invariably lies anterior or superficial to the structures of the cord. It is only in cases of long standing, when the sac is of large size, that the cord may lie along its inner side. Along the site previously occupied in fœtal life by the processus sacciformis, an acquired inguinal hernia might naturally be expected to develop. Nature's obliteration of the processus sacciformis, however, is so complete that the resulting connective-tissue strand can rarely be identified and the process of repair is so effective that, in an acquired inguinal hernia the parietal peritoneum, finding a path of lesser resistance than that along the obliterated pouch, protrudes through the internal ring along the inner side of the cord and close to the outer side of the deep epigastric vessels. In a large number of incipient inguinal hernia, the writer has found this relation constant. Thus, in cases of unilateral bubonocele in adults in which the frequency with which a hernia subsequently develops within a comparatively short time on the non-affected side has led the writer to advise simultaneous operation on both sides when the external abdominal ring of the non-affected side is lax and of increased dimensions on the supposedly non-affected side, even in the absence of the slightest expansile impulse, a small sac, extending only a fraction of an inch along the inner side of the cord is usually, although not always found. This relation of the sac to the cord is not mentioned in the usual text-book description of this subject which ordinarily states that while both epigastric vessels and cord lie to the outer side of the neck of the sac of a direct inguinal hernia, the same structures lie to the inner side of the neck of the sac in the oblique variety. This latter relation unquestionably exists in herniæ of large size and long standing, although in incipient cases and probably as long as the sac lies within the inguinal canal, the neck of the sac lies to the inner side of the cord in both indirect and direct varieties. To account for the gradual change in relationship which may be described as a rotation of the sac around the cord, is difficult. That it actually takes place is well illustrated in a case observed by the writer in which the neck of the sac of an oblique inguinal hernia lying at first to the inner side of the cord came to lie a fraction of an inch below the internal ring anterior to it and a short distance lower down passed to its outer side, in which relation it continued as it emerged through the external abdominal ring. It is not improbable in this instance that later observation would have disclosed the sac lying along the outer side of the cord throughout its entire extent.

* Read before the American Surgical Association, May 6, 1925.

Appreciation of this relation of the sac to the cord in incipient inguinal hernia facilitates the identification and treatment of the sac and thereby forestalls the possibility of its being overlooked with consequent failure to cure the patient. Not that a sac can invariably be demonstrated, even though an expansile impulse has been observed over the internal abdominal ring. The writer has records of two such cases in which no sac was found, in one of which a dilated and tortuous varicocele, extending upward into the inguinal canal, probably accounted by the overdistention of the affected veins in the act of coughing for the expansile impulse simulating that of an ordinary hernia. The writer at least is convinced that the occasional absence of the sac is not due to the spontaneous reducibility of both sac and its contents, for the sac, no matter how diminutive, is always distinctly attached by delicate connective tissue to the adjacent cord from which, however, it can be readily separated by blunt dissection.

The deep epigastric vessels skirt the lower and inner portions of the circumference of the internal abdominal ring. While this constant relation is properly emphasized in all descriptions of hernia, the importance of the artery in contributing to the strength of this region is rarely if ever mentioned. It is well demonstrated in the so-called pantaloon type of hernia in which the peritoneum protrudes on either side of an unyielding vessel, and it is only in old and extremely large herniæ that the vessels may eventually become displaced through the sheer weight of the hernial contents. Contributing as they unquestionably do to the strength of the inguinal canal, the writer believes that the intentional division of these vessels in the treatment of the sac of a pantaloon hernia favors a recurrence and should never be done. In these rather unusual cases, the neck of each sac should be ligated separately, leaving the intervening vessels intact, or if possible, the smaller sac should be drawn down in the larger, leaving the vessels undisturbed.

No consideration of the anatomy of congenital hernia is complete without emphasizing its occasional association with undescended testis. In the most common type of this condition the testis lies within the inguinal canal behind the process sacciformis which extends well below the level of the external ring. In this condition, in the writer's observation, there has never been any obliteration or even narrowing in any part of the processus sacciformis, not even opposite the internal ring where in the normal descent of the testis occlusion is usually complete at the time of birth. That such occlusion may occur while the testis is still undescended is conceivable, and several such instances have been observed by friends of the writer. It must, however, be so rare as not to modify the fact that in every case of undescended testis, the presence of the associated hernia alone justifies operation.

In the operative treatment of inguinal hernia the "Bassini" principle has won a well-deserved general recognition. At the same time its actual technic has undergone certain modifications. Of these, one advocated by the writer is designed to strengthen the region of the external abdominal ring—a region in which perhaps recurrence is most frequently observed. In the typical

Bassini operation the suture of the conjoined tendon to the shelving border invariably distorts the latter structure, especially in herniæ of large size, drawing it upward and inward. In fact, it is rather an approximation of the shelving border to the tendon, rather than of the tendon to the border, especially along the inner extremity of the suture line where, owing to its tendinous character, the muscular arch is decidedly unyielding. To prevent this distortion as well as to strengthen the region of the external abdominal ring, the writer advocates the primary suture of the conjoined tendon to the spine

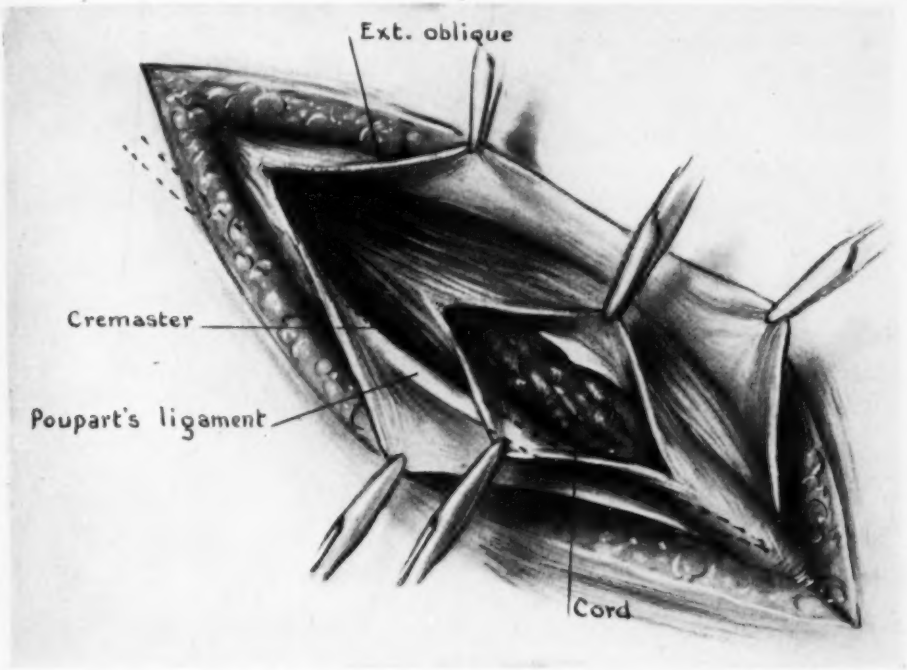


FIG. 1.—Stage I. Exposure of the cord through the divided cremaster.

of the pubis. With the suture in place, the concave arching tendon is converted into a convex one with convex angle closely united to the spine, the inner short side rests against the chest of the pubis while the longer, outer limb is in close proximity to the shelving border to which it is easily sutured without tension and without distortion. The suture to the spine requires a strong, sharply curved needle which is passed beneath the periosteum as closely as possible to the compact bone. The external abdominal ring is further obliterated by the suture—also to the pubic spine—of its original upper and inner pillar, so that when the suture is tightened that structure rests closely against the pubic crest. There are thus two strong unyielding structures, the conjoined tendon and the external oblique aponeurosis, reinforcing and obliterating the region of the original external abdominal ring. A new external ring is formed to the outer side of the pubic spine, of sufficient size to permit the exit of the cord without undue constriction.

The second modification to which the writer has referred is designed to restore the normal dimensions of the inguinal canal, especially in complete herniæ, in which that canal may have been dilated to several times its normal size by the more or less constant presence of hernial contents. This is very satisfactorily affected by an overlapping of the divided external oblique aponeurosis, usually bringing the lower flap superficial to the upper, leaving only sufficient space for the adequate accommodation of the cord.

The writer wishes to emphasize the wisdom of the ligation of the sac at a level with the internal ring, just distal to the deep epigastric vessels. If the neck is of large size a running suture may be used as in the closure of any divided peritoneum. Ordinarily the neck of the sac, well drawn down, is transfixed and ligated on either side. Other steps in the operation do not differ essentially from those generally employed and are fully demonstrated in the accompanying illustrations.

The writer opposed to the use of non-absorbable material, has used chromic gut sutures for many years—the heavier No. "1" for the approximation of the conjoined tendon to the spine and fine No. "0" for all other sutures. An early experience in which silkworm gut was used is responsible for this preference. In this instance, a typical "Bassini" for a reducible bubonocele in an adult male, the patient developed and succumbed five weeks after operation to a rapid acute general miliary tuberculosis. Although the wound gave every indication of having healed primarily, examination revealed a small puddle of pus around each non-absorbable suture. It is quite possible that, in the patient's condition of low vitality, a similar result might have followed the use of plain or chromic gut. The writer is convinced, however, that the approximation of the conjoined tendon to the shelving border may be effected without tension by a preliminary suture of that structure to the pubic spine as already described, and the danger of cutting through of the suture line with or without pus thereby averted.

Opinions differ as to which factor or factors the success of the Bassini operation is due. All seem to agree that a high ligation of the sac at the level of the internal ring is most important. Before the introduction of the Bassini operation, recurrence, after ligation of the sac at as high a point as possible without division of the external oblique aponeurosis, was usually a question of months even when the operation was followed by primary union.

The approximation of the conjoined tendon to the shelving border is considered by many a measure of considerable value. The fact that recurrence frequently appears near the inner extremity of the scar at a point where this approximation in the typical Bassini is least satisfactory and usually carried out under considerable tension, seems to justify the conclusion that approximation of these structures contributes materially to the strength of this part of the abdominal wall. In a paper published in the *Transactions of the Am. Surg. Assn.* for 1923, Seelig seeks to prove by animal experimentation that union between muscle and fascial structures, even in the absence

of tension, does not occur and that shortly after the suture of the conjoined tendon to the shelving border the former structure resumes its original curved position. While any tension under which sutures are inserted may account for defective union, it is not generally maintained that, even in the absence of tension, a union at all comparable to that seen in the origin of the internal oblique and transversalis from their respective portions of Poupart's ligament

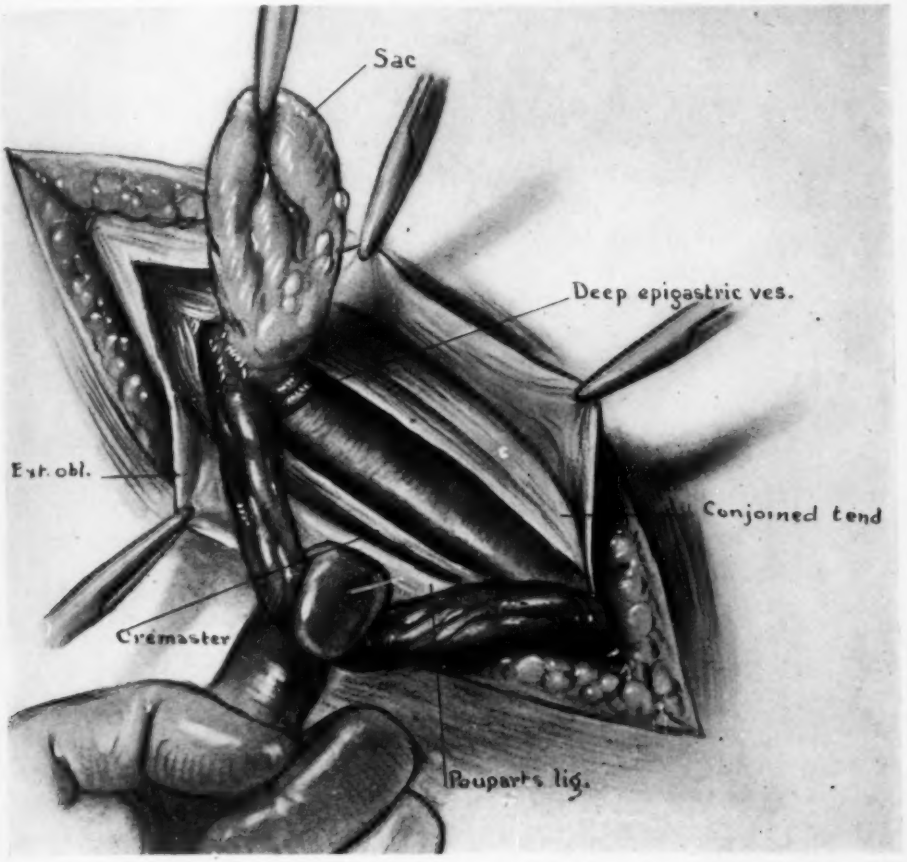


FIG. 2.—Stage II. Separation of hernial sac from cord, with its neck in contact with the deep epigastric vessels.

is to be expected. Even in so-called primary union, opposed surfaces are ultimately united through the medium of a thin layer of cicatricial tissue and similarly in this suture line it is commonly believed that the shelving border and conjoined tendon will be firmly united by a narrow band of cicatricial tissue, of greater width to be sure than seen after a primary union, but still sufficiently narrow to resist the tendency to separate in the way Seelig described. The most important evidence regarding the value of this step in the operation is derived by direct observation, both in cases of recurrence as well as in cases free from recurrence, in which the patient's death has occurred from some intervening disease. Unfortunately as surgeons are not generally

allowed to operate on those recurrences for which they are held responsible, it is frequently difficult to be certain that any special recurrence is not the result of faulty technic in the primary operation. Some years ago I was told by a member of the staff of a hospital in this city to which a considerable number of patients with recurrence applied for relief that in a decided majority of these patients the primary operation had been done in the same hospital by internes without proper supervision. An error to which the inexperienced are exceedingly prone is to mistake the upper part of the cremaster for the conjoined tendon, leading necessarily to an entire lack of a proper suture of that important structure. It is only when the technic of the primary operation has not been defective that observations regarding the relation between the conjoined tendon and shelving border can be of value and in such cases operated on primarily by both himself and colleagues, the writer has found, except at the point of recurrence, so close and firm a union of these structures that sharp dissection was necessary to identify and prepare them for resuture. In the discussion of Seelig's paper, Dowd and Lyle reported cases in which the union of these structures was so firm that separation was impossible and Coley has reported similar cases in his review of Hernia in Progressive Medicine, 1924.

While Seelig does not believe in the approximation of muscle to aponeurosis, he shares the general belief that the union of sutured aponeurotic or fascial planes is much more satisfactory. The overlapping of the upper and lower flaps of the external oblique aponeurosis as practised by the writer after a careful removal of all lining areolar tissue not only restores the normal dimensions of a dilated canal, but adds materially to its strength as well.

As an addendum or an alternative to the suture of the conjoined tendon to the shelving border, various observers have emphasized the value of the careful approximation of the transversalis fascia. This is desirable when the edges of the fascia can be identified, which is not always an easy matter. This fascia, however, is closely united to the deep surface of the conjoined tendon and is necessarily approximated to the shelving border by the suture joining these two structures, leaving, in the vent of union, a more efficient fascial barrier than when the fascial edges are united alone as well as avoiding the danger of puncture of the external iliac vessels with the sheath of which vessels the transversalis fascia is continuous below.

Another measure, evidently of great value, with which the writer has had no experience, is the use of detached long fascial strips in the suture of the deeper planes. This was originally practised by McArthur, of Chicago, in the latter eighties when antiseptic surgery flourished and infection was common. McArthur tells me that he utilized threads from the aponeurosis of the external oblique, in place of the uncertain catgut to which the infection had been ascribed, and with excellent results. Gallie much more recently employs strips from the fascia lata and where close approximation is impossible with-

out tension, inserting them in much the same way as a stocking is darned. This method he especially advocates for large ventral herniæ and reports a considerable number of excellent results in cases considered inoperable by other surgeons. Whether such a "filligree" is more serviceable than the use of a detached flap is questionable. The writer has had excellent results in restoring abdominal defects due to extensive fascial sloughing, even when of very large size, by the transplantation of fascia lata flaps. Andrews, of Chicago, tells me that he has utilized similar flaps in the closure of large

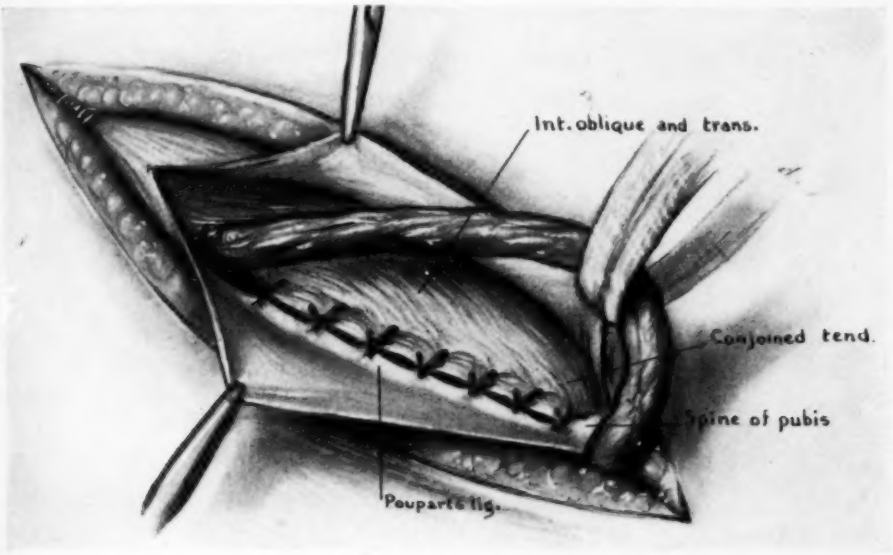


FIG. 3.—Stage III. Suture of conjoined tendon to pubic spine and shelving border.

inguinal herniæ with satisfactory results and the application of one or more such flaps would seem to the inexperienced more simple than the "darning" method advocated by Gallie. It is not probable, however, that any modification of the closure of the hernial orifice by some form of fascial suture or transplant will become a matter of routine except in those cases in which approximation of tendon or aponeurosis is either impossible or can be effected only under great tension. In cases of this character, as well as where recurrence has followed a presumably satisfactory closure by the Bassini method, some such procedure is unquestionably indicated.

The present generation has witnessed almost a complete reversal in the question of the operative *versus* the non-operative treatment of inguinal hernia. Before antiseptic surgery, strangulation, in which taxis failed to relieve, formed the sole indication. During the relatively short antiseptic era almost every operation was promptly followed, even in the absence of infection, by recurrence. Albert, in Vienna, correctly stated that most cases recurred within a year and that recurrence was certain, although it might be delayed for a much longer period. At that time the application of a suitable

truss was usually preferred to operation. With the advent of aseptic surgery, and especially after the publication of the Bassini method, the popularity of operation rapidly increased, the larger number of cases being permanently cured or remaining free from recurrence for years. To be sure, after the wearing of a truss for a year or two, a hernia might occasionally disappear or at least give no indication of its presence. The writer recalls one instance of a good-sized reducible inguinal scrotal hernia in a strong young adult, in which a truss was worn for a year. It was then discontinued, and although thirty-five years have passed by, there has been no indication of a hernia at any time since the truss was discarded. A similar result was observed in a case of a femoral hernia in which after an interval of ten years, a hydrocele of the original hernial sac was excised, at which time no communication whatever between the sac and the peritoneal cavity could be demonstrated. Cases of spontaneous cure are frequently observed in congenital herniæ of infants in which the usual pre-natal closure of the processus sacciformis does not take place until some time after birth. For this reason the writer believes that operation before the third or fourth year is justified only in those cases in which the hernia shows no decrease in size. Similarly in patients of advanced age operation is indicated only where a truss or some form of suspensory apparatus fails to keep the hernia under control. The writer recalls a voluminous reducible inguinal hernia in a male of seventy-eight which confined the patient to a recumbent position in bed or lounge. This was so unendurable in a patient otherwise still strong and active that the alternative of an operation was accepted, and although eighteen months afterward recurrence had taken place, it was of small size and easily controlled by a truss. The possibility of a hernia increasing to such a size as to become finally uncontrollable, notwithstanding the wearing of a truss for many years, is, in the writer's opinion, sufficient justification for operation in every inguinal hernia in patients otherwise healthy in whom the reparative power is still unimpaired. The writer has repeatedly operated on patients who have unintentionally neglected to observe proper supervision in the application of a truss, in which, the hernia, as it increased in size, had slipped down behind the truss without the patient's knowledge. At best, even a well-fitting truss is a nuisance and requires constant skilled supervision to maintain its effectiveness. As patients reach the fifth decade and inguinal regions, formerly flat, become convex from adipose accumulation, the difficulty of the accurate adaptation of a truss is correspondingly increased and frequently a source of much annoyance, especially in hot weather.

The question of the final result in the operative treatment of inguinal hernia is of the greatest interest. The writer presents no statistics. Especially in adults is it difficult to keep trustworthy records, for these patients frequently move and pass from observation. The writer has been accosted by former patients, on whom the operation was done in this city, on the streets of cities in the Middle West, and even as far away as London. It is pre-

cisely in this mobile element of the population that statistics would be of value, for it represents those who gain their livelihood by manual labor, while private patients, much more easily followed, usually have some sedentary occupation that is less likely to subject the abdominal scar to unusual strain. Not that vigorous exercise predisposes to recurrence. In fact, the reverse may be the case, which is well illustrated in a young, athletic male, in which a recurrence gradually disappeared when the patient began to row regularly in a crew. This was thirty years ago and the relief has been complete.

While statistics, based on the results of operative treatment in private

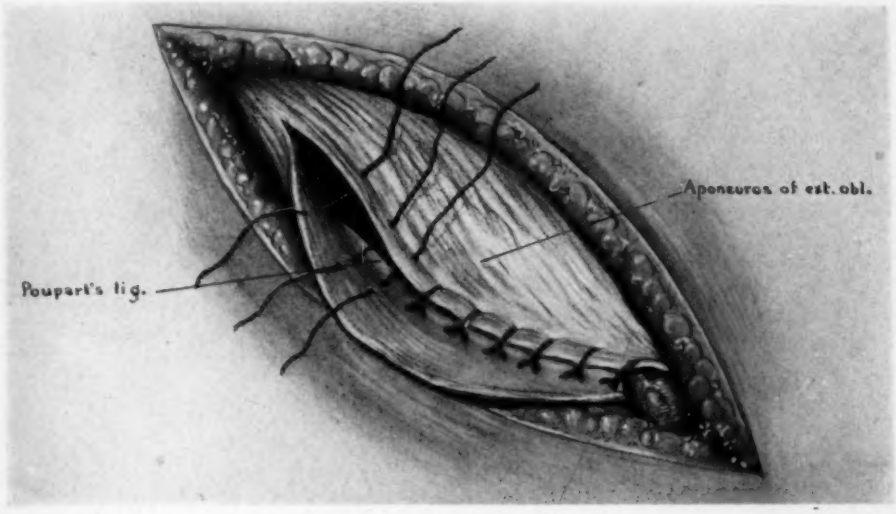


FIG. 4.—Stage IV. Overlapping of external oblique aponeurosis, with formation of new external ring to outer side of pubic spine.

patients, are more easily compiled, the fact that all error in such statistics is not excluded, is shown by the following incident. The writer was recently consulted by an adult of fifty in regard to a recurrence after an operation for inguinal hernia. A herniotomy had been done originally on both sides by a skilled surgeon. Both recurred, the recurrence being repaired by a different surgeon and now another recurrence had appeared. On inquiry as to whether the surgeon who had done the primary operation had spoken of any unusual anatomical weakness which might account for the unlucky recurrence, the patient stated that that surgeon had never been informed of the recurrence and to the best of his knowledge still regarded him as permanently cured.

On the other hand, a surgeon may be unjustly blamed for an alleged recurrence. Thus several years ago the writer operated on a young married woman during the third month of her first pregnancy for an oblique inguinal hernia in which the sac was beginning to protrude through the external ring. About a year afterward a recurrence was said to have taken place, although as the patient had moved to the western part of the State, this could not be confirmed by a personal examination. The patient, however, placed herself again

in the writer's care and proved, on operation, to have a good-sized femoral hernia on the same side, while the original inguinal hernia showed no sign of recurrence. It is needless to emphasize in accuracies of statistics due to differencies in the age of the patient, the duration and type of the hernia, variations in the muscular development of the abdominal wall and other factors which influence the strength of wound repair. Perhaps in syphilitics the success of a herniotomy is more satisfactorily tested than in healthy adults. In a case of this character nine years ago, the writer used a local anæsthetic in

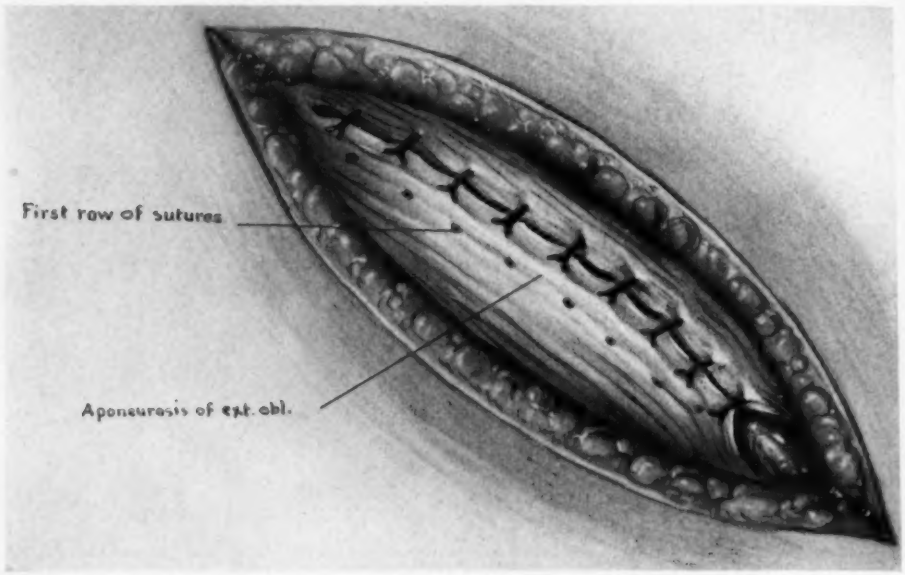


Fig. 5.—Stage V. Final row of sutures, in the overlapping of the aponeurosis.

an operation for a moderately sized reducible direct inguinal hernia extending into the scrotum, in which the wearing of a truss had become intolerable. While primary union was secured, the post-operative course was marked from the ninth to the fourteenth day by an irregularly high temperature accompanied by a sudden enlargement of the liver, which extended like a huge sponge, 4 inches below the costal margin and which, as the temperature subsided, as quickly returned to its previous size. I am told by the family physician that this patient still indulges in occasional alcoholic sprees and that each one is attended by a similar disturbance in the size of the liver and by an irregular temperature. Notwithstanding this habit, however, and the persistence of a markedly positive Wassermann, no recurrence of the hernia has taken place.

Perhaps the best criterion of the value of herniotomy is the verdict of the lay public. When patients, usually of the laboring class, voluntarily seek an operation which means confinement to bed for at least two weeks with a subsequent period of enforced idleness of equal length, it is indeed an indi-

cation that the permanent results are quite satisfactory. This has been for years and continues to be the case with herniotomy, and the popularity of the operation is such that even when patients are warned (and each patient should be warned) of the possibility of a recurrence, they are rarely deterred from seeking to obtain relief for a condition which, both while at work as well as at play, restrains their energy and range of activity. In the writer's experience recurrence, so far as he knows, is a rarity, especially so during the past twenty years during which time, as a routine measure in every operation, the writer has anchored the conjoined tendon to the pubic spine and has restored, by overlapping the divided aponeurosis, the normal dimensions of the inguinal canal.

BROKEN-DOWN ABDOMINAL INCISIONS *

A METHOD OF CLOSURE

By Arthur M. Shipley, M.D.

of Baltimore, Md.

Broken-down wounds have always been a very serious mishap in abdominal surgery. I have seen a considerable number of these accidents occur in the various services of the University Hospital and in the majority of these patients, a fatal termination has been the result. Therefore, I have been particularly anxious to devise some method whereby the outcome might not be so disastrous. Somewhat different methods of abdominal closure are used by the different operators. I believe that tight tying of the sutures, thereby producing a certain amount of necrosis, is a factor in a large number of these broken-down incisions. Most of these patients, however, have had some post-operative complication, either pneumonia, some disturbance in the kidney function or a persistent cough. The wounds, of course, are less apt to do well in patients who are emaciated or whose resistance before operation has been lowered from any cause. In my own experience, there is hardly anything more disturbing than to be called to see a patient with a broken-down abdominal incision with protrusion of coils of the intestines in the dressings. The edges of the wound are usually necrotic, the different layers of the wound are more or less sealed

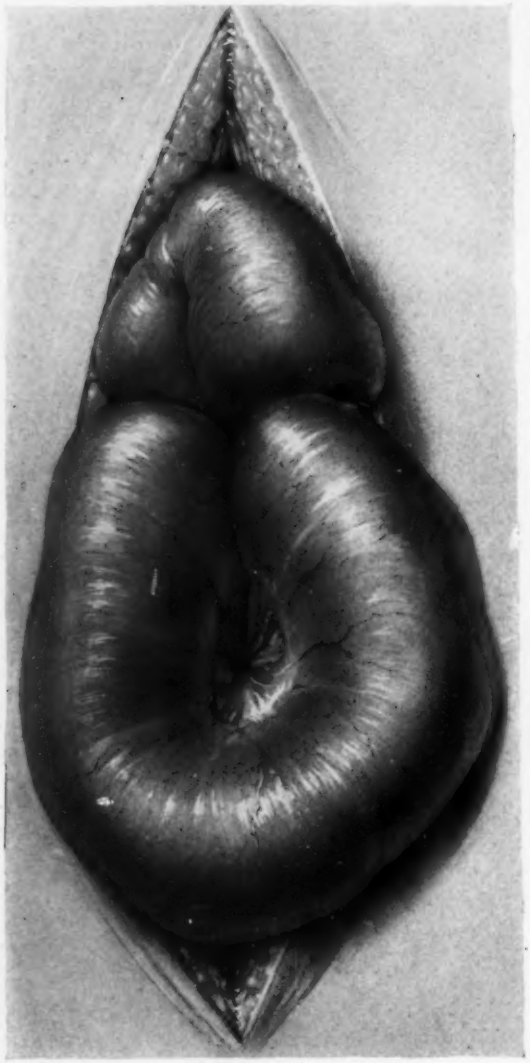


Fig. 1.

* Read before the American Surgical Association, May 4, 1925.

together and the exposed intestine dull in color and often covered by exudate. The patient usually has symptoms of intestinal obstruction, as some portion of the intestine is pinched between the edges of the wound. An anæsthetic given to such a patient is always hazardous because in the act of going to sleep, other coils of intestine are apt to be protruded and the peritoneal cavity become still further contaminated. If one attempts an ordinary closure of such a wound, the necrotic edges interfere with union and a few days after the second closure, the wound is apt to break down again. In order to obviate this difficulty the following procedure has been used:

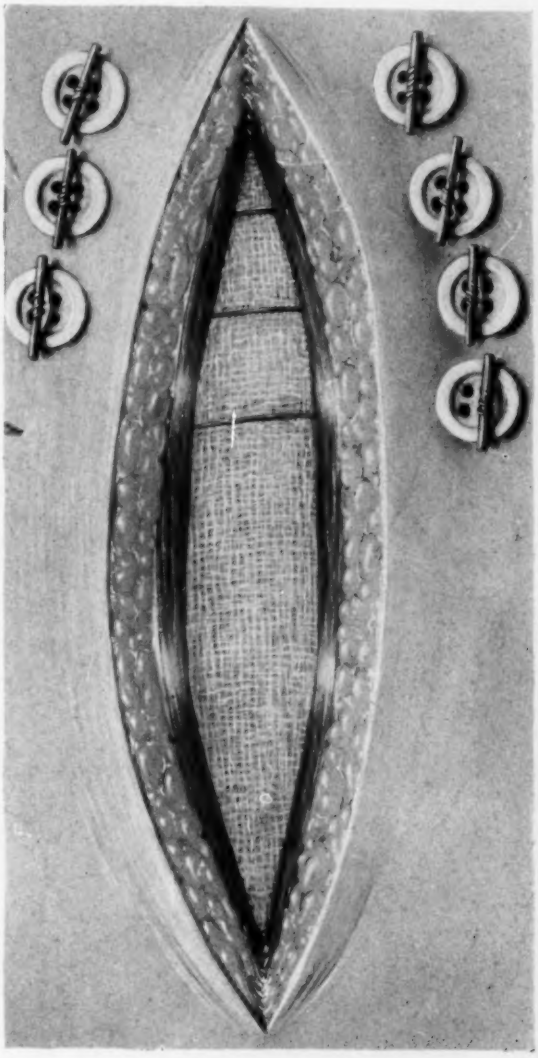


FIG. 2.

The patient is carried to the operating room, the dressings carefully removed, and the patient cautioned to keep as quiet as possible. He is urged not to cough, and if coughing is necessary not to do so without warning. The abdomen around the edges of the wound is shaved and cleansed with alcohol, ether and iodine. The coils of intestine are not handled at this time. (Fig. 1.) The wound is then draped and the abdominal wall infiltrated with novocaine for a distance of about three inches around the wound. The intestines are then gently pushed back within the peritoneal cavity and a quadrilateral piece of gauze containing about eight layers, a little larger than the opening in the peritoneum, is then placed on top of the coils of intestine just below the level of the peritoneum. (Fig. 2.) This prevents further protrusion of the intestines and also acts as a drain. Interrupted sutures of No. 22 silver wire are then introduced through the entire thickness of the abdominal wall, starting about an inch to an inch and a half from the skin edge and coming out through the peritoneum just lateral to the wound

margin. (Fig. 2.) The wire is then introduced through the entire thickness of the abdominal wall on the opposite side in the reverse manner, using a large curved needle. These sutures are placed at about one-half inch intervals and an ordinary bone button is threaded over each end of the wire and the wire is drawn moderately tight by twisting a matchstick down on the button. (Fig. 3.) These interrupted wire sutures lie outside of the layer of gauze which thereby protects the underlying intestine from erosion by the wire, and prevents coils of intestine from protruding between the wire sutures. Another longitudinal piece of gauze is placed down in the wound external to the wire. This strip is narrow and is put in for drainage as it is not hoped to get primary union because of the necrotic edges. (Fig. 4.) The edges of the wound are then approximated by tightening the wire. After a few days when the wound edges are healthy and red and granulations present, the gauze under the wire becomes loose and can be easily removed. The wires are then further tightened in order to closely approximate the posterior or peritoneal layer of the wound. (Fig. 5.) A small pack of gauze is left for a few days longer, external to the wire for drainage. By the end of ten days all gauze can be removed and the wound edges closely approximated, after which union takes place by granulation rather promptly. Five patients have been treated successfully in the Surgical Clinic of the University Hospital, Baltimore, Md., by the above method.

FIG. 3.

Case I.—This man was a young negro who had been shot through the abdomen about an hour before admission. He was operated on by the Resident. He was partially drunk and took a bad anæsthetic. An upper right rectus incision was made because the wound of entrance was in the upper abdomen. A number of perforations of the small intestine were found and closed. In closing the incision, continuous plain catgut was used for the peritoneum and interrupted chromic gut for the rectus sheath. This suture line was safeguarded by interrupted silkworm gut sutures through the skin, subcutaneous tissues and anterior sheath of the rectus muscle. The skin was closed with silk. This is the usual closure in the Surgical Clinic of the University Hospital. The patient developed pneumonia following operation and was quite ill. He coughed a great deal and on the tenth day after operation complained of pain following a coughing spell. When the wound was examined it had broken down throughout its length, and a number of coils of small intestine were found in the dressings. I was called to see him. The edges of the wound were necrotic and covered by exudate. The intestines were fairly clean. The peritoneum was somewhat dull and glazed.

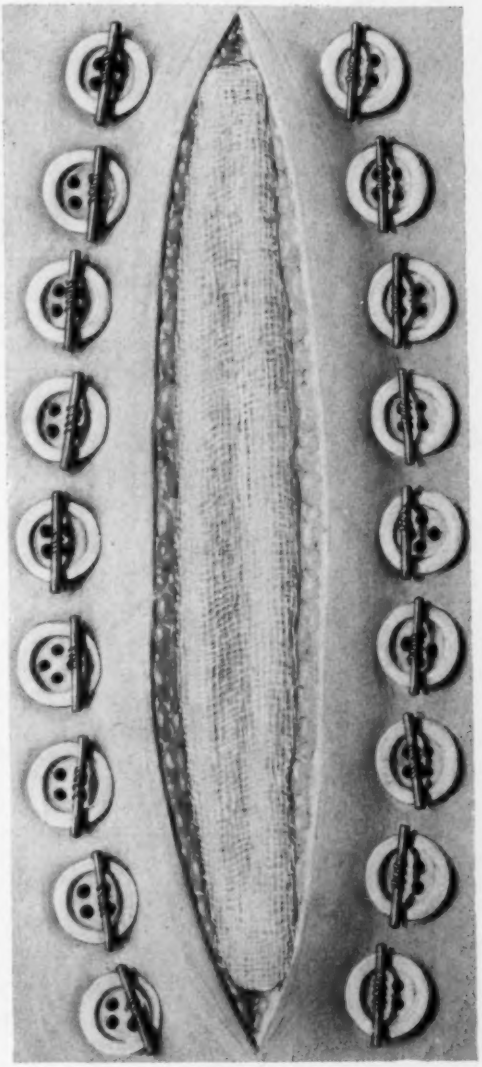


Fig. 4.

Under local anæsthesia, the wound was closed by the method described above. Patient made a good recovery and left the hospital at the end of four weeks, with a solid abdominal wall.

Case II.—This patient was a colored man between the ages of fifty and sixty. He had had a very large, irreducible scrotal hernia for years. He came in with his hernia strangulated and was operated on by the Resident. The hernia was a very large one and in addition to being strangulated was adherent. There were a number of coils of small intestine which were strangulated and there was a sliding hernia of the cæcum as well. Considerable difficulty was encountered in freeing the cæcum and the tissues were much handled. A long incision was necessary. After the intestines were reduced the hernia was closed with chromic gut and the skin with silk.

This patient developed almost complete suppression of urine following the operation. This persisted for a number of days. There was some œdema of the extremities and considerable moisture in the lungs. Following this, he began to improve, but developed a good deal of cough. On the eighth day after operation he complained of pain in the wound and was dressed. The wound was found completely broken down and several

coils of small intestine were found in the dressings. I was called to see him and found the edges of the wound heavily infected and covered by exudate. The coils of the intestines were also covered by exudate and there was considerable discharge. The wound was closed by the method described above and this patient also made an uneventful recovery.

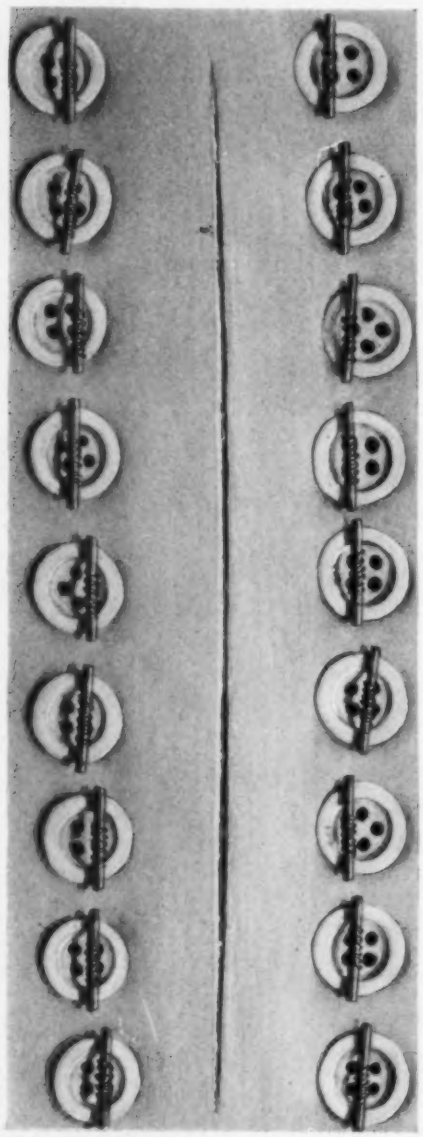


FIG. 5.

CASE III.—This patient was a negro, male, who had been shot in the abdomen about an hour before admission. His wound of entrance was in the upper abdomen and a right rectus incision was made. There was a perforating wound of the stomach and considerable hemorrhage from a wound in the mesentery. The perforations were sutured and the abdomen closed without drainage. This patient also developed pneumonia with a great deal of cough. On the twelfth day following the operation, his wound broke down with protrusion of a number of coils of small intestine. The same operative procedure was performed under local anæsthesia and he also made a good recovery.

CASE IV.—This patient was operated on by Dr. C. A. Reifschneider for acute cholecystitis. The gall-bladder was distended and acutely inflamed and the head of the pancreas was enlarged and indurated. Cholecystostomy was done. The abdominal incision was closed around the drains. Plain catgut was used in the peritoneum, chromic gut in the fascia and silkworm gut through the skin, subcutaneous tissue and fascia. The skin was sutured with interrupted silk. He was having a good convalescence, the drains were all out and the abdomen was soft until the fourth day after operation, when he developed some cough, which became progressively worse. On the seventh day after operation, he suffered severe pain in his incision. The nurse noticed some blood in the dressings and when they were examined there was protrusion of the intestines in the incision. Doctor Reifschneider saw the patient immediately and there was rather more than the usual exudate because the wound was a drained one. The intestines, however, were clean and glistening. A secondary closure was done after the manner described above. Gauze was removed on the twelfth day. One silver wire was removed twenty-six days after the operation and the remaining ones removed one month after operation. He has been seen from time to time since the operation and has had no further trouble from the incision.

CASE V.—This patient was operated on by me. He was a white man, sixty-two years of age, who came in with a diagnosis of pyloric obstruction. He had lost a great deal of weight from starvation at the time of admission, and at operation an extensive carcinoma of the pylorus was found which caused almost complete obstruction.

The carcinoma had extended along the posterior wall to such an extent that posterior gastro-enterostomy could not be done. An anterior gastro-enterostomy was done, as the anterior wall except at the pylorus was free from cancer. After operation, the patient developed an obscure chest complication with cough and fever and considerable expectoration. No definite pneumonia could be made out, but he was quite ill for a number of days. His abdomen continued soft and he had no pain in the abdomen and no vomiting. The eleventh day after operation his abdominal wound broke down throughout its length and a number of coils of small intestine protruded through the incision. There was very little infection. The edges of the wound, however, were necrotic and covered with grayish exudate.

Under local anæsthesia, the described procedure was done. He made a good recovery and left the hospital four weeks later with his incision healed. This happened only a few months ago, and he is still living.

PARTIAL RESECTION OF THE KIDNEY*

By Edward Starr Judd, M.D.
of Rochester, Minn.

Resection of the kidney has been only rarely performed in recent years. During the period of evolution of renal surgery, partial resection was not infrequently advised and carried out. Czerny performed the first partial resection for a tumor of the lower pole of the kidney in 1887. Later Kummell resected the lower pole of a kidney for echinococcus disease. Kuster reviewed thirty cases in which a partial resection was performed: four for tuberculosis, two for stone, three for hydronephrosis, and five for tumors. Eighteen of the patients improved, seven did not improve, and five died. Apparently the results following partial resection did not find favor with the surgeons of that day as very little further is to be found in the literature concerning the subject. The mortality in this type of case (16 per cent.) was comparatively low in the early period of renal surgery; nephrectomy was then being performed with a mortality of from 25 to 35 per cent.

We know now that in the presence of a tuberculous process or a neoplasm, nephrectomy should be performed whenever possible. Under ordinary circumstances, if the opposite kidney is functioning normally, resection of the diseased area with an attempt to preserve a small, possibly infected fragment of a kidney, is not entirely satisfactory. Such an operation entails considerable risk and not infrequently a secondary emergency operation. On the other hand, there are certain cases of localized infection, formation of stone, and limited hydronephrosis which would readily lend themselves to a partial resection of the affected kidney.

Young recently reported a case in which he had resected the upper third of the right kidney for localized pyonephrosis and stone. The kidney had been operated on previously and there were extensive adhesions. A slight depression in the body of the kidney suggested duplication, but the pelvis was single. The patient was cystoscoped some time later; the remnant of the kidney was functioning, although apparently reduced. Young also cites a case reported by König in 1919, in which resection and suture of the atrophic upper pole were performed and a stone removed.

A few years ago, Hinman made a most important contribution to the experimental studies of compensatory hypertrophy; these have since been partially confirmed experimentally, and our clinical evidence supports his contention. His experiments show that renal reserve and compensatory hypertrophy effect a counter-balance following unilateral nephrectomy, and also that in unilateral diseases without nephrectomy, an additional factor which he calls renal competition is active in the final readjustment. He believes that the

* Read before the American Surgical Association, May 5, 1925.

unilateral lesion creates an unequal ability to work, one side being healthy and active, and the other diseased and less active, and that such activity is essential to renal growth. The gradually increasing demands on the kidney for work stimulates the tissue to greater activity and results in renal hypertrophy. Hinman also believes that inactivity is just as significant of renal atrophy and that a diseased renal mass in competition with a hypertrophic mate gets less and less stimulation as the other side becomes more efficient, and so progressive inactivity leads to a disease atrophy. It is evident, then, that the existence of this renal reserve power and compensatory hypertrophy on one side and what he calls renal competition and disease atrophy on the other, is a most important consideration in any surgical disease of the kidney. He cited his experiments to show that many of the failures from plastic operations for unilateral hydronephrosis were due to the fact that the diseased kidney had been badly injured and the opposite kidney had been called on to increase its activity. Regardless of the fact that the diseased kidney could be so changed as to overcome any mechanical difficulties, it was often impossible for it to resume its work because of lack of stimulation, all of the work being done by its hypertrophic mate. Hinman believes that the initial response on the repaired side is toward repair, but it is too feeble to compete with the hypertrophic side, and that the final atrophy is not a progressive toxic degeneration as much as it is a disuse atrophy.

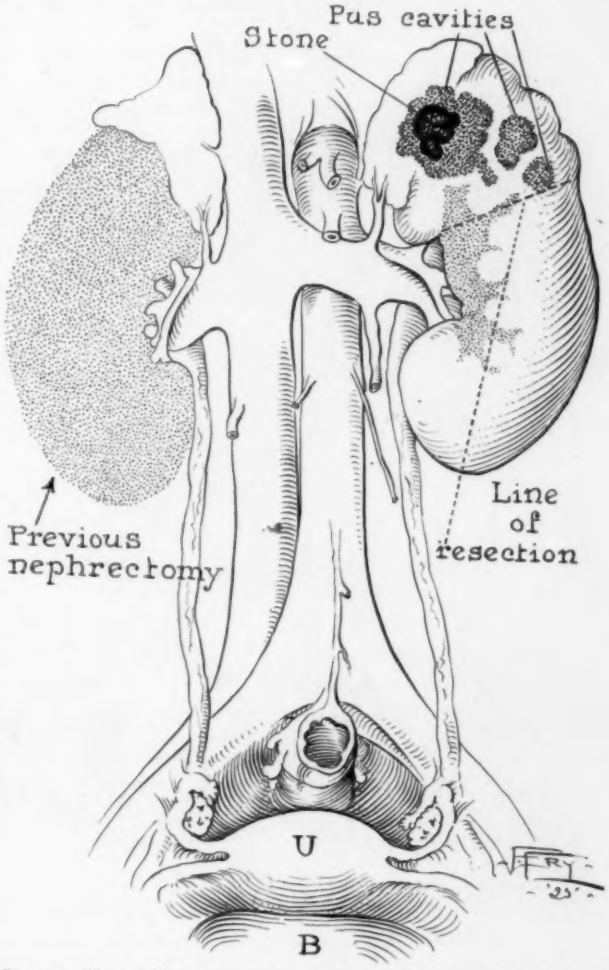


FIG. 1.—Right kidney removed; pyonephrosis of the upper third of the left kidney.

The foregoing conception of hypertrophy and atrophy of the kidney must

have a very important bearing in operating in cases of bilateral renal lithiasis and hydronephrosis, and especially in performing resections. It is obvious that to resect a kidney when it is known that the opposite kidney is doing practically all of the work will not be advisable. The only thing to be gained by saving a piece of renal tissue in any case in which the opposite kidney is uninjured would be the slight protection which it would offer in case of

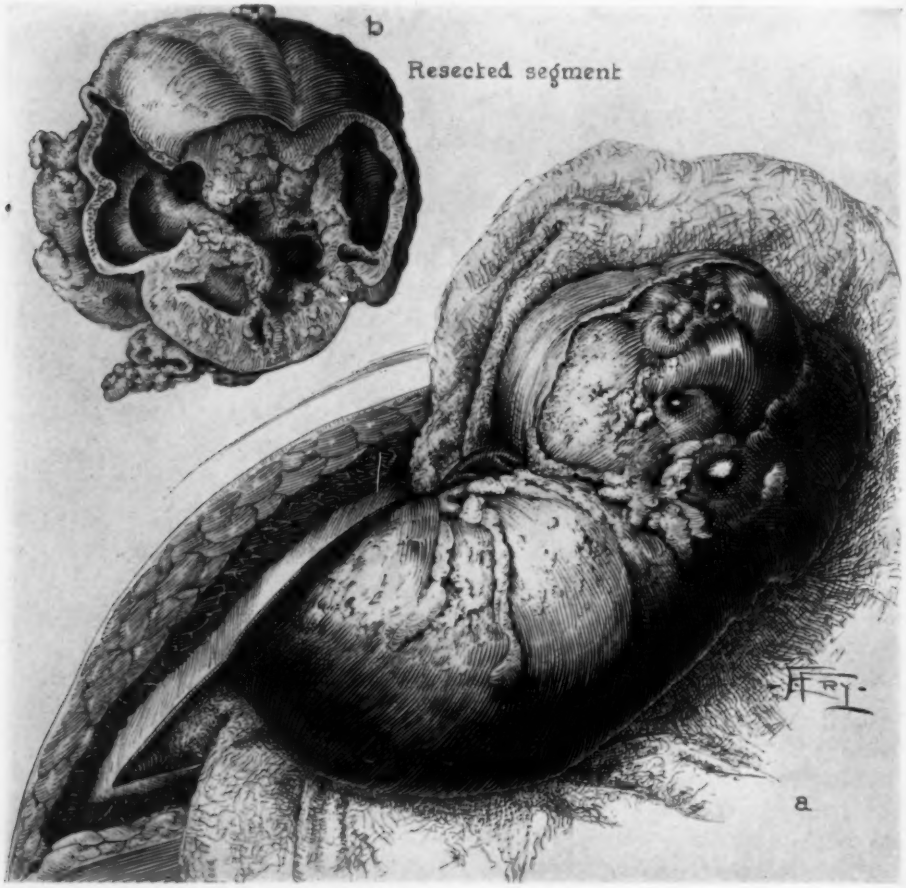


FIG. 2.—a. Left kidney with diseased upper segment; b. segment resected.

trauma to the good kidney. Undoubtedly in some of the cases in which a resection was performed, there was immediate atrophy of the renal tissue saved, because the opposite kidney was enlarged and perfectly capable of carrying on all of the work.

In an occasional case, partial resection may be the only operation permissible; the diseased portion may be associated with, or be part of, the only remaining functioning segment of renal tissue, making it essential to conserve as much of the kidney as possible. This was true in one case in which the right kidney had been removed and the left contained a localized pyonephrosis and stone. The work of Tuffier, thirty-five years ago, justifies such an opera-

tion. Tuffier demonstrated that there is a definite regeneration of tissue in the remaining renal segment if the portion allowed to remain is sound. Kummell excised a portion of a kidney in two cases for stone and abscess formation. He cites Tuffier's work in which it was estimated that a man could live with from 80 to 100 gm. of sound renal tissue.

CASE I.—*Partial Resection of a Single Kidney.*—A woman, aged thirty-two, had had attacks of fever, chills, and pyuria for seven years, and recently a dull aching pain in the right side associated with frequency of urination and nausea. The right kidney was enlarged and the urine contained pus. The X-ray revealed several shadows in the region of the right kidney, and a single large shadow in the region of the left. Cystoscopic examination disclosed a functionless right pyonephrosis and infection and stone in the left kidney, which, however, was functioning normally.

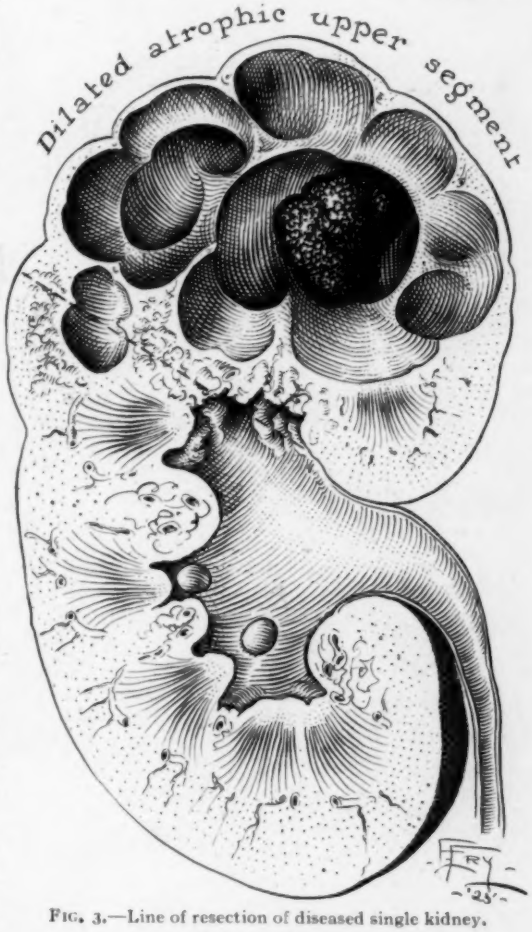


FIG. 3.—Line of resection of diseased single kidney.

A right nephrectomy was performed and the patient recovered readily from the operation. Three months later the left kidney was operated on. In the upper pole was a large abscess which contained one large and several small stones. The lower pole was in fair condition. The adrenal was adherent to the abscess area; it was dissected free and pushed back. The abscess area containing the stones was then resected. Tissue to the amount of about two-thirds of a normal kidney remained after the resection. The edges of this portion were approximated with a continuous running suture. Several large stay sutures of catgut were also inserted. A moderate amount of urine drained through the incision for a number of days, but on the fourteenth day the wound was clean and solid. The patient had no further trouble; five months after operation she became pregnant, and seven months later gave birth to a child that lived fourteen days. One year later her blood urea content was normal and she was in good condition. (Figs. 1, 2, 3 and 4.)

The blood urea in this case had been normal before operation, and during convalescence accurate records were kept. On the second post-operative day the blood urea was 72 mg. for each 100 c.c., on the fourth day 92 mg., on the ninth day 56 mg., and on the thirteenth day 44 mg., which would seem to indicate that the renal function was probably very definitely interfered with at the time of the resection. After the patient returned home her local physician kept the record. In about two months' time the urea

content was normal and remained normal thereafter. The only other sign of renal disturbance at any time, in spite of the intervening protracted labor, was a trace of albumin. This case seems to demonstrate definitely that a part of one kidney is sufficient

FIG. 4.—Closure of line of resection of kidney in two layers.

for normal renal function, even if there is an added hazard, such as may accompany pregnancy.

Resection is often indicated in cases of double kidney. The position of the double kidney does not differ from that of the normal kidney, and its relation to normal surrounding structures is similar. The double kidney, however, is

usually abnormally elongated. It varies in size, depending on the degree of union of the two segments and the extent of the interrenal area. Externally there may be no evidence of duplication, although in most cases the division of the two segments is indicated by a depression varying from a small notch to a broad deep groove. The capsule may dip into the renal mass completely separating the two segments. It is necessary, surgically, to know the extent of the separation and the integrity of each segment in order to make any conservative or partial resection, and it is necessary to remove all of the diseased segment and leave a normal functioning unit. In cases of extensive infection of one segment the adjacent intervening tissue is generally affected. The infection may not have extended to the other segment sufficiently to involve the pelvis, but on resection it may be spread by surgical manipulation and rapidly invade the apparently normal tissue. If there is tuberculosis, resection should rarely be considered. Tubercles and giant cells were found in the interrenal tissues in six cases in which nephrectomy was performed for tuberculosis in double kidney; in two of these the process was limited grossly to one segment. A tuberculous stricture at the point of juncture of the two ureters may cause disease in both portions of the kidney, one segment being tuberculous and the other hydronephrotic from ureteral obstruction. In several cases I have resected tuberculous kidneys, sending to the laboratory pieces of

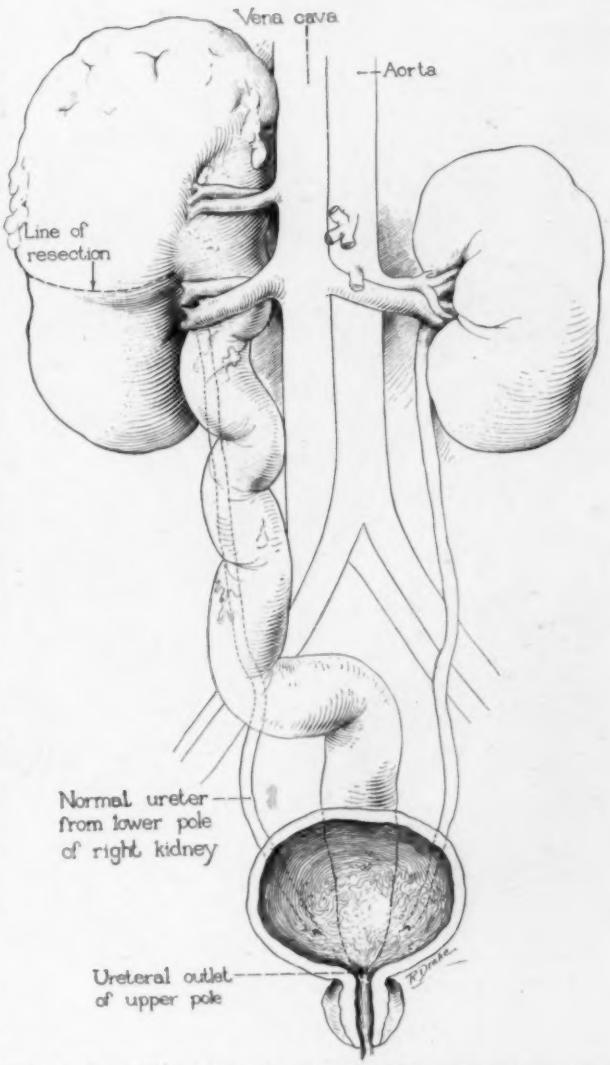


FIG. 5.—Large dilated upper segment of the kidney with a tremendous ureter opening into the posterior urethra.

tissue excised from the segment which I proposed to save, only to find that the tissue contained tubercles. Sometimes a cicatricial band separates the two segments, grossly walling off the infected area and apparently offering an ideal condition for operation. Resection in the presence of any extensive

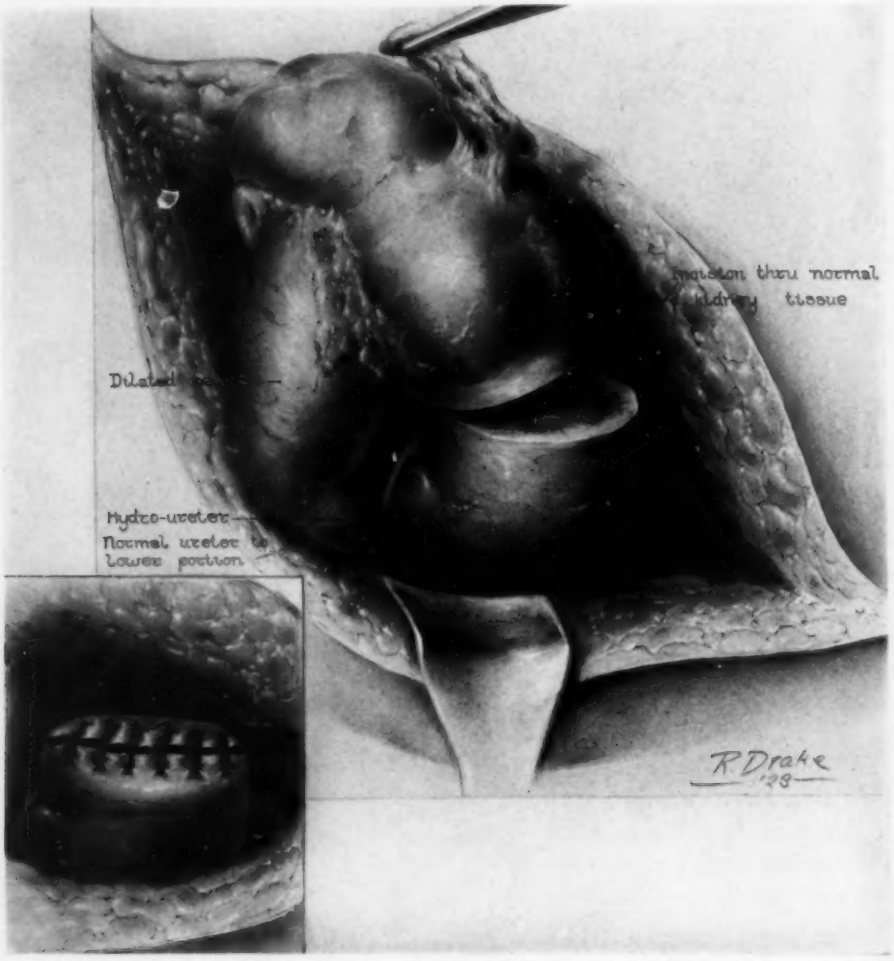


FIG. 6.—Resection of the upper dilated segment of a double kidney with a partial ureterectomy.

infection is likely to result in a stormy post-operative course, and complete nephrectomy may be necessary later.

Opening into one of the calices or the pelvis may cause a urinary sinus. This often occurs in cases in which a resection is done, but the sinuses heal promptly and it is likely that as the technical steps in the operative procedures are developed, this difficulty will be eliminated.

The segment which remains must have a sufficient blood supply. In most cases in which the pelvis is completely divided, the parts have a separate blood supply. The arteries arise from the aorta and the veins extend to

the vena cava. The diseased segment, generally the upper, may be smaller than the remaining portion and may receive only a small branch from the aorta or from the main renal artery, the main branch of which enters the larger segment and furnishes sufficient blood to permit resection. Eisendrath studied the blood supply in thirty-five cases of double kidney; in fifteen cases one artery supplied both segments; in fifteen there was an artery for each segment, and in five, three arteries supplied both segments.

In operating, the kidney is approached through a posterolateral incision; its mobility will depend on the vascular pedicle, the extent of the lesion, and amount of perinephritic adhesion. The vascular connections to the normal segment are first examined to make sure that they are adequate. The pedicle to the remaining segment is then clamped, cut, and ligated. Anomalous vessels are not uncommon and must be looked for. The kidney should be resected through normal tissue, and a portion of this tissue left attached to the segment to be removed in order to avoid possible error and infection. Sometimes the diseased segment may be composed merely of a fibrous hydronephrotic sac containing little or no functioning renal tissue, and the dilated sac may be peeled from the remaining kidney as though it were a simple cyst. The renal stump is closed with a double interrupted or mattress suture which dips deeply into the renal tissue. Any bleeding, or any area not well approximated, may be controlled with a running stitch. The area of resection is then covered by a portion of the fatty capsule stitched loosely over the line of suture. The area of resection may drain for several days, and a drainage tube is used.

If the bifurcation is high, the ureter may be removed just a little above the juncture of the normal ureter. Care must be taken not to injure the common ureter or the one draining the adjoining segment. If there is ureteral obstruction in cases of complete duplication, it is generally at the ureterovesical juncture. The ureter is dilated and not infrequently infected; it should be removed completely.

There were six cases in the present series in which a double kidney was resected. Four of these cases were reported in an earlier paper by Braasch and Scholl. Reports of two follow:

CASE II.—*Ureter from One Segment of the Double Kidney Opening Extravesically.*—A man, aged forty-nine, had had intermittent pain in the right loin for twenty-six years. The urine contained much pus. X-ray examination of the kidneys, ureters and bladder was negative. Cystoscopic examination revealed two normally placed ureteral orifices in the bladder and a third in the posterior urethra. A pyelogram of the right kidney from which the urine was normal, and also an injection into the ureter opening into the urethra, disclosed a double kidney on the right side. The lower segment was apparently normal in size and function. The upper segment was markedly dilated, and the ureter from it was from 3 to 5 cm. in diameter. The upper segment was not functioning.

On exploration through a posterolateral incision, the right kidney was found to be twice normal size with a double blood supply, two pelves, and two ureters. The lower segment was normal in size and consistency, as was the condition of the pelvis and ureter. The upper segment was hydronephrotic and the ureter was tremendously dilated. The

vascular pedicle to the upper segment was clamped, ligated, and cut. The upper half of the kidney was removed, the line of incision passing through normal renal tissue. The slight bleeding which occurred when the kidney was divided was controlled by continuous and interrupted sutures. The wound was dry at the completion of the operation. The segment remaining was equivalent to about two-thirds of a normal kidney. The wound was closed with two soft drains; these were removed on the eighth day. The patient had an uneventful convalescence. One year later, he reported that he had had no further urinary trouble. (Figs. 5 and 6.)

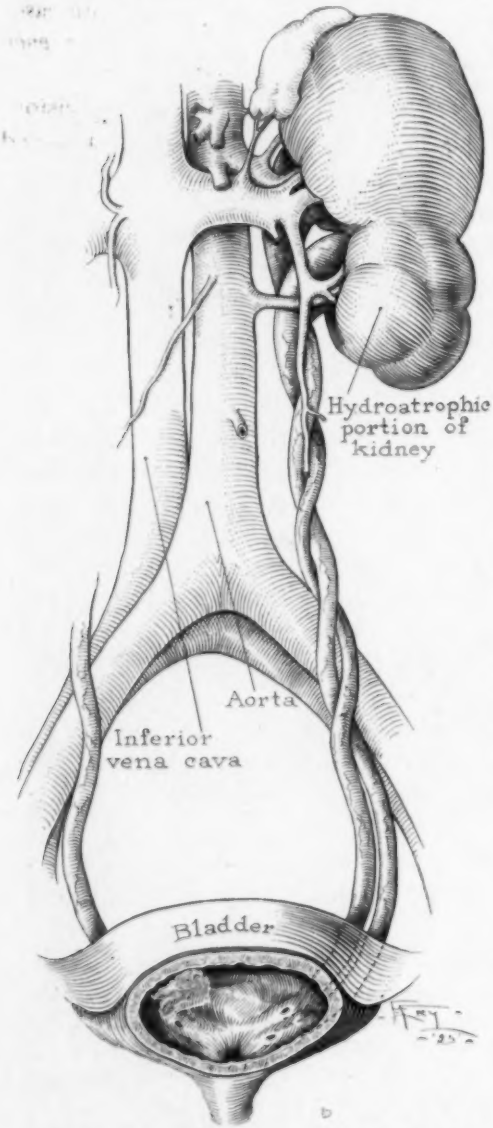


FIG. 7.—Atrophic lower segment of double kidney with complete duplication of the ureters. The ureters make two complete spirals, one around the other.

CASE III.—*Pyuria with Occasional Attacks of Chills and Fever Since Childhood.*—A girl, aged eighteen, had had frequency for four years, and at one time difficulty in voiding. During the last year she had aches and pains in the left lumbar area and upper abdomen. On examination the right kidney was palpable. The urine contained a moderate amount of pus, but renal functional tests were normal. Röntgenograms of the kidneys, ureters, and bladder were negative.

Cystoscopic and pyelographic examinations revealed complete duplication of the left pelvis and ureter. The lower pelvis was slightly dilated and infected, and the ureter from this segment entered the bladder laterally and above the orifice from the upper segment. There was practically no function in the lower segment. The urine was normal from the upper segment which was functioning well. The right kidney was normal.

The left kidney was exposed through a posterolateral incision. The kidney delivered well into the wound and was found to be duplicated with a definite line of demarcation between the two segments. The upper segment felt normal. It was of good size and had a complete blood supply. The ureter was not dilated and was not adherent to the ureter of the lower segment. The lower segment was sac-like. When filled with fluid during the cystoscopic examination, it was of fair size, but at operation was found to be atrophic and contracted. It received an artery from the aorta. The renal vein from this segment connected with that from the upper segment. The two segments were separated by making an incision at the sulcus. The vascular pedicle to the lower segment was clamped and cut, and the ureter was cut and ligated about 12 cm. below

the kidney. The incision was drained but healed promptly. After operation the patient's father, who was a physician, stated that this was the first time since childhood that her urine had not contained pus. (Figs. 7 and 8.)

It was my intention to discuss here only resection of the kidney in cases

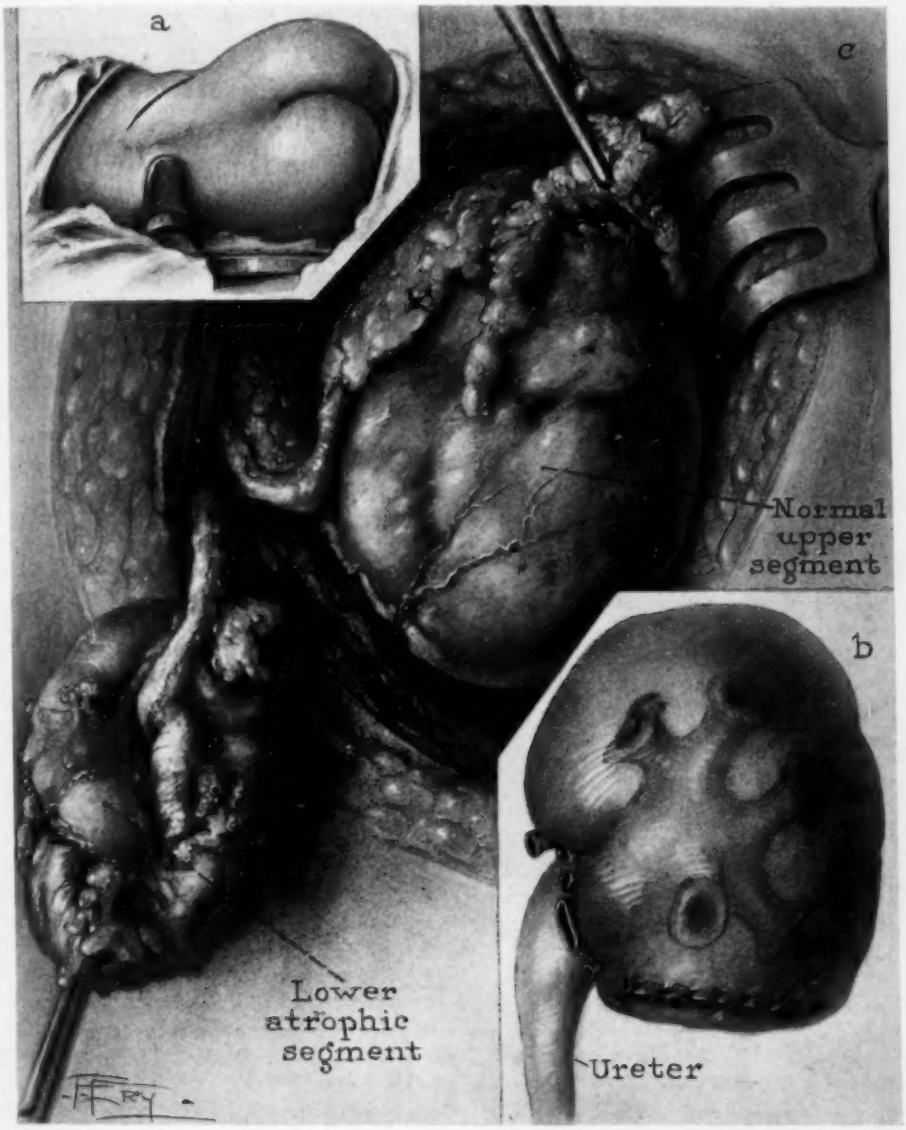


FIG. 8.—a. Line of incision; b. Resection of lower atrophic segment of a double kidney. The line of suture is covered with fat and the normal segment so placed in incision as to permit the ureter to be straight. c. Line of closure of resected area of kidney.

of solitary or double kidney, but I wish also to relate my experience in resecting horseshoe kidneys. The problems encountered in making a diagnosis in such cases and the plan of operative procedure are quite different

from that in the ordinary cases of renal disease. The numerous and anomalous vessels, and the fixation and location of the renal mass make an anatomic recognition of horseshoe kidney necessary in order to carry out successfully any surgical procedure. The blood-vessels and the pelves in horseshoe kidneys lie anteriorly. In some cases there may be a single artery from the aorta which divides and supplies both renal masses. Accessibility for surgical intervention in a horseshoe kidney varies inversely with the degree of fusion. In most cases these kidneys occupy a position median and caudal to normal kidneys. The more complete the fusion, the lower the position. Often it is best to approach the horseshoe kidney through an anterior incision.

I have performed resection in nine cases of horseshoe kidney. The immediate risk of the procedure, if the infection is rather extensive, is fairly high. In one case tuberculosis was present, but it seemed to be confined to one segment only. In this case, the wound drained freely for several months and then healed permanently. The last report gave no evidence of a recurrence of the tuberculosis.

Case IV.—*Horseshoe Kidney.*—A man, aged thirty-five, had had a traumatic rupture of the right kidney repaired in December, 1916. Since then he had had repeated attacks of pain in the right lumbar region, and sometimes severe colic. He weighed 146 pounds. The systolic blood-pressure was 90, and the diastolic 65. The specific gravity of the urine was 1.020; there was acid reaction, albumin 2, pus 4, and 1 erythrocyte. Hæmoglobin was 55 per cent., and the leucocytes numbered 6200. The Wassermann reaction was negative; the phenolsulphonephthalein return was 50 per cent. in two hours. Röntgenograms of the kidneys, ureters and bladder disclosed a large stone in the right kidney. A diagnosis of right calcareous pyonephrosis was made. May 28, 1919, the wound was opened and white mucus discharged.

A right subscapular nephrectomy was performed June 6, 1919. A posterolateral incision was made. Right pyonephrosis was found with chronic nephritis. The kidney removed, was small and atrophied, weighing 68 gm. There was considerable scar tissue about it, and it contained a pyonephrotic sac 3 cm. in diameter. The kidney was stripped out from its capsule. No stones could be felt in the pelvis of the kidney or in the ureter, and there was too much infection to warrant exploring the peritoneum at this time.

The patient returned April 7, 1921, because during the last year he had had several attacks of pain in the left renal area with fever. He weighed 153 pounds. The systolic blood-pressure was 108, and the diastolic 68. Urinalysis revealed a specific gravity of 1.016, acidity, albumin 3, pus 4, and 1 erythrocyte. Hæmoglobin was 80 per cent., and the leucocytes numbered 7800. The phenolsulphonephthalein return was 45 per cent. in two hours. Röntgenograms of the kidneys, ureters, and bladder, showed a large shadow over the right renal area. A cystogram revealed pus 4 on the right side. A lead catheter was passed up to a stone, 4 by 4 cm., at the ureteropelvic juncture. The ureter was dilated 4, and acting as a diverticulum. The patient was advised to have a right ureterectomy.

April 13, 1921, a right rectus incision was made, and a partial nephrectomy and ureterectomy performed. An iodoform gauze pack and two drainage tubes were inserted. The lower end of the right ureter was exposed and divided, and ligated with chromic catgut. Dissection was carried up to a pocket, apparently a horseshoe kidney, containing a stone. The right part had been removed previously. The stone was apparently in the pelvis of the kidney. A piece of renal tissue, about 5 by 3.75 cm., was removed from the lower pole of the right kidney which extended across to the spine. The patient

returned July 19, 1922, because of a right lumbar sinus which drained purulent material but no urine. The phenolsulphonephthalein return was 45 per cent. in two hours. The specific gravity of the urine was 1.018; there was acid reaction, albumin 1, and pus 1. July 24, the sinus was explored, curetted, and packed with gauze. In January, 1924, it was reported that the lumbar sinus was still draining.

CASE V.—*Double Meatus, Ureter and Pelvis on Right Side, with Stricture of Inner Ureter Above Bladder and Dilatation Above Stricture.*—A woman, aged thirty-two, came to the clinic August 14, 1911. For six or seven years she had had pain and soreness through the right side of the abdomen. Four years before, she had had an attack of severe pain in the right flank, which radiated anteriorly to the bladder, lasted about two hours, and was associated with a constant desire to urinate. No blood or stone was passed. Four weeks before coming to the clinic there had been a similar attack. Several physicians had diagnosed the symptoms as gall-stones.

At examination the patient weighed 125 pounds; urinalysis revealed a specific gravity of 1.017, an acid reaction, albumin 1, but no pus. Röntgenograms of the kidneys, ureters and bladder were negative. A cystogram and pyelogram revealed duplication of the meatus on the right side, about 1.25 cm. from the other; also a duplication of the ureter and pelvis on the right side, and a stricture of the inner ureter just above the bladder with marked dilatation of the ureter above the stricture. Clear urine was coming from each meatus. The left kidney was normal. An exploratory operation, performed August 28, disclosed the double ureter on the right side, stricture of the inner ureter at the bladder wall, and dilatation above, the size of the small intestine. The ureters ran separately to a point about 15 cm. from the bladder where they approximated and ran in the same sheath for a distance of several centimetres, separating again above, and entering the separate pelves very close to one another, the diseased ureter entering behind and the sound one in front. Each half of the kidney had its own blood-vessels. The diseased ureter was the upper one; the upper artery and vein were tied. On sectioning the kidney in the central point of the apparent separation, there was no bleeding. The upper ureter was injected with methyl blue. When cut across, the side injected was not opened, the section being made about the middle of the kidney. A long anterior oblique incision was made and the upper and lower muscle split. The lower part of the ureter was tied and turned in like an appendix, about 3.13 cm. from the bladder, at a point where the sound ureter which lay a little below to the outer side was so closely adherent as to make it dangerous to separate it. The sound ureter went into the lower pole on the anterior side, and the unsound ureter posterior to the upper half. The patient made an uneventful recovery and left the hospital on the twelfth day after operation. One year later she reported that she was perfectly well.

CASE VI.—*Double Ureter and Pelvis of Both Kidneys with Stones.*—A man, aged forty-five, came to the clinic October 9, 1911. Seven years before, he had had hæmaturia and passed a large stone, and since then there had been pus in the urine. Two years later he had had severe chills at intervals of several months, followed by high fever, from 104° to 105°. During the last three years there had been intermittent pain in the left upper abdomen and around the left lumbar region, with tenderness over the left kidney. The knee-jerks disappeared. Urinalysis revealed a specific gravity of 1.013, an acid reaction, a faint trace of albumin, an occasional red blood cell, and pus. Röntgenograms showed a shadow in the area of the left kidney. A cystogram revealed duplication of the ureter and pelvis of the left kidney, and a stone in the lower pelvis. The urine from this pelvis was cloudy, indicating considerable destruction of the lower half of the kidney. The urine from the upper pelvis was clear. A pyelogram disclosed a stone in the lower pelvis, which was moderately enlarged. Apparently there was a fairly distinct division between the two halves of the kidney.

October 19, half of the left kidney and half of the two ureters and two pelves were resected through a post-oblique incision. The pelvis in the lower half was dilated, infected, and contained a stone and about an ounce of infected material. The lower

half of the kidney was soft and about half the size of the upper. The ureter was large and inside the pelvis it contained a papilloma. The sound ureter ran posterior to the diseased one, and entered the bladder below. The sound ureter passed behind and to the outside of the diseased one at the brim of the pelvis. The blood-vessels of the lower half were distinct from those of the upper. The line of demarcation between the diseased and sound ureters was well outlined. Catgut was used to tie the ureter and to suture the kidney. One cigarette drain was inserted.

The patient was examined again April 2, 1912, when he complained of severe pain over the left kidney. A cystogram revealed a double ureter and pelvis on the right side. Function was good on the right side, but only fair on the left. The remainder of the left kidney was removed April 4. It contained a chronic infarct and was hydronephrotic. The patient was seen several times afterward, and the urine always contained pus. He died January 31, 1924, from renal insufficiency.

CASE VII.—*Bilateral Duplication of Ureters and Pelves.*—A woman, aged forty-one, came to the clinic May 30, 1918. Her appendix and right ovary had been removed fifteen years before. Two and one-half years before, she had had acute nephritis and bloody urine for eight weeks. During the last year she had had several attacks of fever, pain in the left renal area, and much pus in the urine. One month before, there had been a severe attack of pain radiating to the bladder.

The patient weighed 146 pounds. The systolic blood-pressure was 160, and the diastolic 100. Urinalysis revealed a specific gravity of 1.012, an acid reaction, albumin 2, pus 2, and red blood cell 1. Hæmoglobin was 69 per cent., and the leucocytes numbered 5000. The phenolsulphonephthalein return was 60 per cent. in two hours. The Wassermann reaction was negative. Röntgenograms of the kidneys, ureters, and bladder showed multiple shadows in the left renal area. A cystogram and pyelogram disclosed bilateral duplication of the ureters and pelves, multiple stones in the lower pelvis of the left kidney. The differential phenolsulphonephthalein return was 10 per cent. from the left upper pelvis, and only a trace from the lower. The return from the bladder was 35 per cent.

A partial left nephrectomy was performed through a posterolateral incision July 9, 1918. Four rubber tissue drains were inserted. The left kidney contained two pelves; the lower half consisted of a hydronephrotic sac, about 12 cm. in diameter, with stones. It would, however, seem that the hydronephrosis was caused by a kinking blood-vessel rather than by a stone. The large sac containing stones was dissected out and the lower portion of the kidney, all of which was diseased, was amputated, the upper two-fifths with small pelvis and ureter being preserved. The cut surface was closed with catgut. The patient continued to have fever and local infection. A cystogram, taken August 3, showed that the remaining portion of the kidney, possibly equal to one-third of a normal kidney, was still functioning. August 15, the remainder of the left kidney was removed by a subcapsular nephrectomy. July 11, 1923, word was received that the patient was perfectly well.

CASE VIII.—*Double Kidney with Branched Stone in the Lower Pelvis.*—A man, aged twenty-seven, came to the clinic March 10, 1920. Appendectomy had been performed the year before. At the age of twelve the patient had begun to have attacks of pain in the right side and back about twice a week, but never severe enough for a hypodermic. For the last three years there had been almost constant soreness on the right side with repeated attacks of acute pain. During the last year a hot water bag had been applied every night for relief. The appendectomy did not afford relief. There were no urinary symptoms.

The patient weighed 111 pounds. The systolic blood-pressure was 120, and the diastolic 66. Urinalysis revealed a specific gravity of 1.023, an acid reaction, albumin 0, pus 1, and red blood cells 2. Hæmoglobin was 70 per cent., and the leucocytes numbered 10,600. The phenolsulphonephthalein return was 65 per cent. in two hours. Röntgenograms of the kidneys, ureters, and bladder showed a shadow over the right renal area.

A cystogram revealed turbid urine from the right meatus. A differential functional test proved that the renal function was normal on both sides. The first pyelogram showed a small highly situated pelvis suggestive of duplication. The X-ray shadow was below the pelvis. The second pyelogram showed complete duplication of the pelvis with the shadow obscured by the lower pelvis which was otherwise normal. The diagnosis was branched stone in the lower pelvis of a double kidney.

Right heminephrectomy was performed March 23. Exploration revealed two pelves and two ureters, the ureters joined about 1.88 cm. below the two pelves. The lower third of the kidney contained a branched stone and a number of small stones, also small separated cortical abscesses containing stones. The lower ureter had been closed by a stricture at the juncture of the two ureters. It was ligated close to the juncture of the upper ureter. The lower third of the kidney was dissected out completely and removed in the groove which formed a distinct division between the upper two-thirds and the lower third. The remainder of the kidney was stitched over and covered by a fatty fascial flap. The patient made an uneventful recovery except for a persisting sinus which discharged serous material. A cystogram April 15 revealed clear spurts of urine coming from the right meatus. A report October 11, 1923, stated that the patient was perfectly well. The sinus remained open for one and one-half years, and then closed permanently.

CONCLUSIONS

1. It is entirely feasible to perform resection even in cases of solitary kidney, and it should be done whenever a more complete removal of the infection can be accomplished.

2. Resection of double kidney is practical, provided the disease is definitely confined to one segment. Just as in cases of solitary kidney the resection can undoubtedly be made whether the kidney is double or single.

3. For the present, one should be contented with nephrectomy in most cases of tuberculosis. Even in what appears to be very early cases, the infection usually involves more of the renal tissue than can be demonstrated except by microscopic examination.

4. Before resecting renal tissue, we must take into consideration the amount of renal hypertrophy and atrophy, so that we may save a segment of the kidney that will be of some service to the patient.

METHODS OF URETERAL REPAIR AND TRANSPLANTATION

By Charles H. Mayo, M.D.
of Rochester, Minn.

Exstrophy of the bladder is a serious, uncomfortable and dangerous affection. It is as well most disagreeable for those who are necessarily associated with the sufferer. The mortality from such anomalies has been stated to be 50 per cent. within the first ten years of life; only one of seventy patients reaches the age of seventy. Many have associated defects which add to the seriousness of the condition.

The Röntgen-ray indicates that in most of these cases of exstrophy spina bifida occulta co-exists; it may, in fact, be responsible for the exstrophy. In females the uterus is quite often bifid, or even completely double with a double vagina. Pregnancy and normal childbirth have been rarely reported in such conditions. One patient with a bifid uterus operated on at the clinic twelve years ago by the method described, married three years ago and gave birth to twins during the last year.

Transplantation of the ureters has been performed in sixty of ninety-four cases of exstrophy. In one case a dead kidney on one side, from total obstruction of the ureter, made but one ureteral transplant possible into the recto-sigmoid. This patient, operated on seven years ago, has continued in good health.

The constant rubbing of the exposed mucous membrane of the bladder against clothing and absorbent dressings may incite it to malignant change. I have seen four cases of carcinoma of this area; three of the patients are now dead.

With experience in several methods of operation for the relief of these distressing conditions, I am opposed to any method of developing a new bladder sac by using the mucous membrane, skin flaps, or skin grafting. No nervous or automatic control of the outlet can be established, and the more completely the bladder is developed the more dangerous is the condition of the patient. Neither do I recommend any form of closed intestinal pouch as an artificial bladder, since it is as susceptible to sepsis, has no automatic control, and hence leads as surely to chronic pyelonephritis. The Coffey technic is better than that described by the Russian and Polish surgeons, who surround the ureter with the whole thickness of the bowel and thus prevent the valve action secured by the Coffey procedure.

A few changes in the technic have been developed which relieve some of the possible temporary complications of the operation. The operations I have performed have been intraperitoneal. Judd has performed the operation extraperitoneally by exposing and dividing the ureter extraperitoneally, open-

* Read before the American Surgical Association, May 6, 1925.

ing the peritoneum, drawing out a loop of sigmoid for the anastomosis, after which it is replaced and fixed within the peritoneum, the ureter remaining behind the peritoneum until it pierces the wall of the bowel.

The intraperitoneal operation should be performed on the right ureter first, as the sigmoid is more difficult to handle on the right side after being fixed by an anastomosis on the left side. The incisions are oblique abdominal. The ureter can be seen attached to the back wall of the pelvic peritoneum. Its situation can be determined by the wave of peristalsis in it when the point of a forceps is drawn across its covering layer of peritoneum. The peritoneum is opened and the ureter separated down to a point from 2.5 to 4 cm. above the bladder. The ureter is divided and held in forceps and the lower end ligated. The peritoneum is then closed by suture, just leaving the ureter loose as it passes through the opening in it. A needle with No. 2 chromic catgut is now passed 0.6 cm. up the lumen of the obliquely cut end of the ureter, out through its wall, and then passed in again 0.3 cm. further on. It is then carried down the lumen of the ureter again and out at the open end. Two knots are tied and the short end of catgut 6.25 cm. long, is not cut but is passed into the lumen upwards its full length. This is a most important recent development in technic. The long end is left hanging for future use. The bowel is now cut longitudinally, in line with, or down, the centre of a longitudinal muscle band 3.75 cm. long. This cut does not open the mucous membrane. The sharp edge of the knife is pushed against each side of the cut muscle and peritoneum, separating the cut edges 0.90 cm. With a sharp small pointed knife a puncture of the same size as the ureter is made in the mucous membrane at the lower end of the incision in the bowel. The outer flap of the incised bowel is trimmed at the upper end to just the depth of its dissection in order to make room for the ureter to lie in the trough against the mucous membrane without being pinched at this point. The ureter is stripped and loosened for 6.25 cm. It may become kinked and fail to deliver urine for two or three days through a half paralyzed lower end of ureter. The curved needle with the thread of chromic gut that was left hanging from the lumen of the ureter is now passed into the lumen of bowel by way of the puncture described and out through the bowel wall 1.5 cm. below the opening; the thread drawn tight draws the ureter into the bowel.

A needle bite is now taken in the wall of the bowel and the thread tied to fix the end of ureter within the bowel at this point. In suturing the dissected flaps, every other stitch catches the outer tissue of the ureter to fix it. The peritoneum is now closed over the ureter by interrupted sutures. A running suture is employed to cover these sutures as well as the fixing suture which holds the end of the ureter in place.

With slight modifications this is the Coffey plan of anastomosis. It permits of free compression of the ureter by pressure of contents of the bowel against the mucous membrane, closing the ureter without interfering with the ureteral peristalsis. This method, I believe, is better than folding the whole thickness of the bowel around the ureter, because the stiff tube prevents the

pressure of the solid or fluid contents of the bowel from acting as a valve to allow egress of urine without entry of bowel contents into the ureter. In nearly all cases urine is absorbed by the bowel for a few days, as it is like a Murphy drip of salt water. There is almost no absorption from the second ureteral transplant after the ten or twelve days necessary to establish the first tolerance. With only half the urine in the bowel at first, there is less trouble than if both ureters are transplanted the same day. The urine, by following the short end of thread lying in the ureter, can always leak into the bowel regardless of slight kinks in the ureter which might otherwise be obstructive. Nearly all cases show some evidence of pyelitis, which soon disappears. Children under four should not be operated on as they must be old enough to attend to their own clothing and toilet. Within a short period, the urine should be retained during the day from two to four hours; during the night it is usually retained for eight hours.

The mucosa of the bladder with ureteral stumps is removed about one or two weeks after the second ureter is transplanted.

The mortality is very low for the apparent seriousness of the operative procedure, being but 13.33 per cent. in the sixty patients operated on. Operation is justified by the relief which follows it. The condition is rare, occurring in only one in 50,000 births, but in spite of its rarity, the rate indicates that a number are born every year who will require relief.

IMPLANTATION OF AN OVARY*

By William L. Estes, M.D.
of Bethlehem, Pa.

Physiologists and clinicians are able now to differentiate two qualities in ovarian function, namely, (*a*) the genetic and (*b*) the purely hormone quality. The Graffian follicles found especially in the superficial or cortical areas of the ovary carry the genetic functions, and the interstitial cells in the stroma of the mid-gland region possess the hormone qualities.

Menstruation and many of the physiologic phenomena of ovulation will continue if a part of an ovary be preserved in its proper position, or if only a part of an ovary can be saved and it be implanted or transplanted within the blood and lymph circuit of the abdominal cavity. This is well known and well established. It is not yet fully determined that all the hormone functions will be preserved if the implanted ovarian fragment be a mere slice of the superficial part of one ovary.

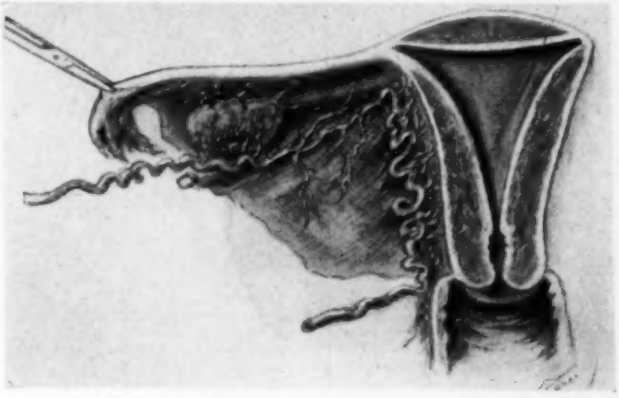


Fig. 1.—This is to show the blood supply of the ovary. The small vessel which runs along within the folds of the ovarian ligament is indicated. This should be preserved.

It is very sure that when the oviducts are entirely lost or firmly closed that sterility will result even if ovulation and menstruation should continue.

Also many and various nervous phenomena are apt to develop in sterile women whose Fallopian tubes are permanently closed and there is no possible way for the ova to reach the inside of the uterus.

In short, the conditions for the normal functioning of the generative organs and ovulating cycle with all the physiologic phenomena this implies, require more than Graffian follicles, their maturation, rupture and the resulting corpora lutea. For full and complete function, the interstitial cells of the ovary must also be preserved so that they may function, and as was said the ova should have a discharge avenue into the uterus and there exercise their usual stimulus for involution, etc.

There remains still the question whether the most disagreeable nervous phenomena, and the sometimes tremendous psychic storms which follow the complete removal of all of both ovaries in young women are due to the loss

* Read before the American Surgical Association, May 6, 1925.

of the genetic functions, the loss of the hormone function, or to the loss of both of these functions of the ovary. As the thyroid and ovarian physiologic interrelationship is so close, one might easily reason that the loss of the ovarian hormone might have a very far-reaching effect. The psychic effect of the complete and irretrievable loss of the generative functions is always bad. The preservation of as much as possible of ovarian stroma is, therefore, the duty of every surgeon who must operate on the internal generative apparatus of a young woman.

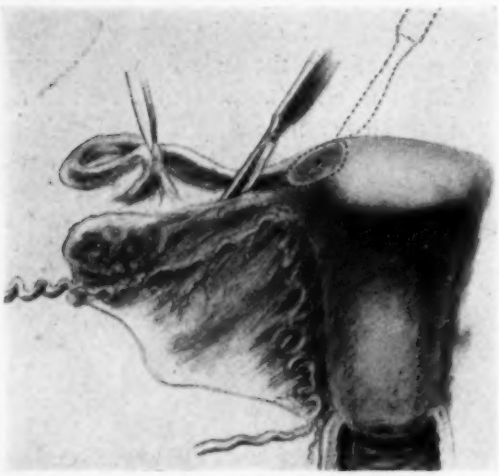


FIG. 2.—This shows the manner in which the tube should be exsected. The artist has not represented the technic quite right. The incision for the exsection of the tube from the uterine horn should go much deeper, that is to say, to the mucous lining of the uterus. This produces somewhat of a crater-like depression into which the ovary should be fitted.

Furthermore, cases in which the oviducts are completely and hopelessly destroyed should, when it is possible, have some avenue made or the ovary be so placed, that ripe ova may find an entrance into the uterine cavity.

Conditions possible for fertilization and pregnancy may be brought about, if functioning ovarian stroma be implanted upon the mucous lining of the uterus directly over the inner opening of one or both Fallopian tubes in the horns of the uterus. This is what is accomplished by the method of implanting ovaries, I wish again to describe and to recommend after twenty years of experience in the use of the method.

In regard to pregnancies I make no extravagant assertion or claim. Pregnancy may and has occurred after the operation, but in the majority of the cases it has not occurred. If, however, it should in forty-six cases occur five times, the method being unobjectionable as compared with other operations for retaining a part of the ovary, it is certainly worth continued use in the conditions for which such conservative attempts are indicated.

Conditions for Which the Operation is Adapted.—In women between fifteen and forty years of age, who for any reason have had complete irremediable stenosis or destruction of the Fallopian tubes, the operation is indicated. This is not meant for cases where there is simple constriction at one place from twisting, flexions or adhesions. These may be remedied without removal of the tubes. The operation is indicated and may be employed in cases where most of the tube is stenosed and so diseased it would not be safe to retain it; that is to say, in all sorts of obliterative salpingitis. It is recommended in cases of gonorrhœal or tuberculous salpingitis, when the tubes are hopelessly diseased, but the ovaries are not wholly affected; in the

various inflammatory conditions, except streptococcus hæmolyticus, which may invade the pelves of women, and by continuity or contiguity destroy the tubes.

The necessity in these implantations is, that the whole of both ovaries shall not be diseased and that the uterus shall be in such condition it may be left in place. It is desirable and best to retain as much of the ovarian stroma as the disease and condition make possible. Even a small portion of the ovary saved will serve for the continuation of menstruation, however. I have implanted an ovary in the stump left after a subtotal hysterectomy with perfect success, and though of course menstruation did not recur, the phenomena of ovulation did go on regularly.

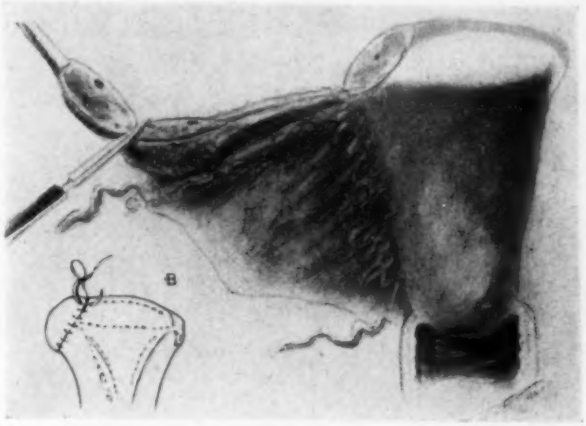


FIG. 3a.—This illustration is not correct. The lower and free border of the ovary should be excised, not the upper border which is attached to and covered by the broad ligament. Also the excision from the uterine horn should have an oval depression and the excised surface of the ovary should have an answering projecting oval surface to fit into the cavity in the horn.

Technic of the Operation.—In cases in which the necessary slight manipulations are not apt to prove dangerous on account of a possible rupture of an abscess into the peritoneal cavity, after carefully bathing and disinfecting the vulva and vagina, the uterus is curetted, swabbed out with tincture of iodin, and packed with iodoform gauze. The abdomen is then opened; after carefully protecting the general abdominal cavity with warm, moist towels, while the woman is in the Tredelenburg position, the adhesions are broken up, the tubes carefully liberated and all pus and detritus sponged out, and the pelvis dried and packed with moist towels. The tubes are completely exsected from the horns of the uterus by rather a free oval incision which reaches quite to the attachment of the round ligaments on the sides of the uterus,

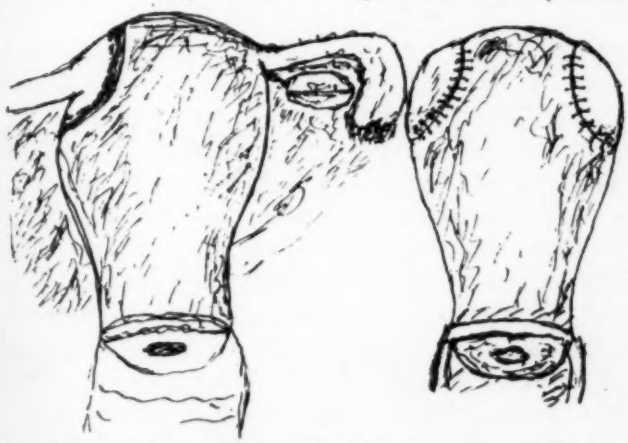


FIG. 3b.—These two rough schematic figures give a better idea of the excision of a tube and the fitted-in implants of the ovary.

and to the mucous membrane of the uterus within, immediately over the opening of the Fallopian tube; this opening may be slightly enlarged by a dilator. As a rule, in pus cases, the broad ligaments are so thickened and softened and are so adherent to the tubes, that a mass ligature is passed around the outer folds of the broad ligament, outside the tube, and the ovarian vessels tied off. After this, all the involved upper part of the broad ligament is removed with the tube, including the uterine insertion. Frequently it is necessary to cut through the uterine attachment of the round

FIG. 4.—This shows the manner in which the side, which for any reason will not be implanted, is approached and exsected.

ligament, in order to get rid of all infected tissues. Both tubes are treated in like manner. When only one ovary may be implanted, after exsecting both tubes, the stump of the broad ligament on the side opposite the retained ovary is first sutured to the horn of the uterus, then the implant is fixed and properly covered.

The ovaries will have been liberated in the separation of the tubes and the evacuation of the abscess cavities. If not fully liberated they should now be freed and carefully examined. Then all the degenerated part of the ovaries should be exsected by cutting away if possible the lower unattached part of the organs. The ovarian ligament should be preserved, if practicable with its small artery, and the attachments to the broad ligaments also, if it can be done without leaving bad tissue behind. This is not essential, however, as completely exsected portions of the ovarian stroma may be implanted. The portion of the ovarian stroma which is left is cut in such a pattern that it will fit into the oval concavity left in the horns of the uterus when the tubes are exsected. These portions of ovary should be successively drawn over, placed with their raw surface fitting into the oval concavities in the horns of the uterus, and fastened in place in the uterine walls by running sutures of No. 1 chromicized catgut all around their edges. The stumps of the round ligaments and broad ligaments are then brought into apposition with the sides of the uterus in such a way that the implanted segment of ovary is entirely covered by the serous membrane of these ligaments. This serves the double purpose of steadying and fixing the uterus in position and

protects the grafts from possible adhesions to the intestines or omentum. When drainage is necessary, and it frequently is in these cases, it is made through Douglas' cul-de-sac into the vagina by an iodoform gauze strip packed into the ragged cavity so frequently left in the pelvis, or by a cigarette drain, or by tubes, and the ends passed through the small puncture into the vagina. This packing or drain may be removed in from five to six days as a rule.

Mauclaire, writing sometime ago in *Archives Generales de Chirurgie,* on the subject of ovarian grafts, recommended anastomosing the ovarian vessel with some others, preferably the epigastric, in doing ovarian grafting. He thinks an assured blood supply is most necessary for success in these operations. Undoubtedly he is right in one sense, for the grafts would surely atrophy and become useless without a proper blood supply. In my method, the blood supply from the uterine vessels to the ovary is never, or rarely, cut off completely. But even if it is, the ovarian graft fitting directly into the walls of the very vascular uterus, soon will establish a blood supply which is quite adequate for even this organ, though it must have a rich supply of blood.

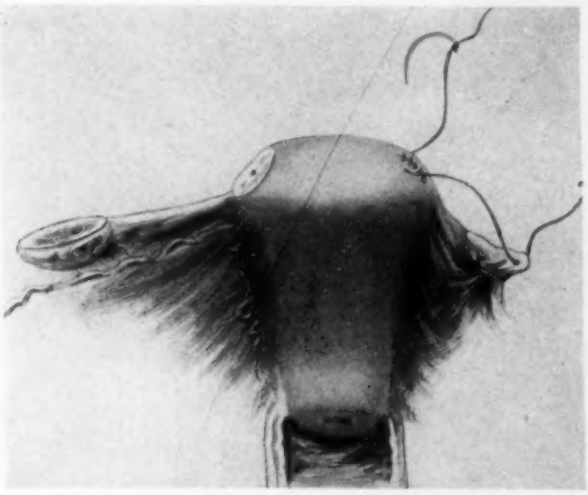


FIG. 5.—This shows how the stump of the broad ligament on the side not implanted is tied off and brought by sutures to the sutured horn of the uterus and made to cover over the wound and to steady this side of the uterus.

Results of the Operation.—More than a hundred ovarian implantations after this method have been done in the clinic at St. Luke's Hospital. I myself investigated fifty of the cases done by myself over eight years ago. My son, Dr. W. L. Estes, Jr., recently investigated ninety-three cases, including my personal cases and those done by Dr. W. P. Walker and himself. In this list of ninety-three cases, two deaths are recorded following the operation, from general septic peritonitis; the result of extensions of already far-advanced septic inflammations in the pelvis. It is not recorded whether these fatal cases had a streptococcal infection or not. It is, however, my opinion that the implantation should not be done in cases of streptococcal infection.

In only forty-five cases could we obtain complete and accurate information concerning the result of the operation.

Of the forty-five cases, twenty-two women had been pregnant before the operation, twenty-three had never been pregnant.

Pregnancy.—After the operation four of our cases became pregnant, two went to full term and bore normal healthy children, two cases aborted at about three months' pregnancy. Dr. Thomas C. Zulick, of Easton, Pa., in a personal communication, informed me that a woman about thirty-three years of age who had never been pregnant, upon whom he did an ovarian implantation after my method, on account of complete stenosis of both tubes from a gonorrhœal infection, became pregnant, and bore a healthy child at full term. This makes five pregnancies in forty-six cases, or 10.8 per cent.

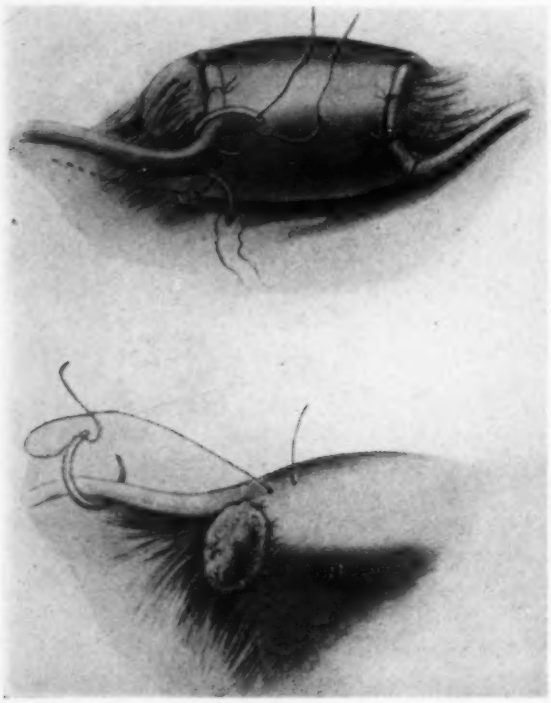


FIG. 6.—This shows the ovarian fragment implanted into and sutured to the horn of the uterus in the lower picture. The upper picture indicates how the broad and round ligaments are brought over the horns of the uterus, sutured and made to cover and to protect the implant and to steady and support the uterus in the pelvis.

Menstruation.—Only four patients out of forty-five failed to menstruate after the operation. These cases were 23, 28, 32 and 37 years old, respectively. The 23-year-old patient had already had two operations done on her pelvic organs. One tube and ovary had been removed. The remaining tube had a gonorrhœal infection and the ovarian stroma was almost entirely destroyed by cystic degeneration. All the pelvic contents were matted together by dense adhesions; only a very small portion of ovarian stroma could be retained and implanted. This woman already neurotic and hysterical, never menstruated after the operation; she continued very nervous and ailing, though she escaped the "hot flashes" and other vaso-motor disturbances which follow suddenly arrested ovulation. No very definite information except that she did not menstruate after the operation was obtained from the 28-year-old patient.

In her case, too, only a very small portion of one ovary could be retained for the implantation.

The 32-year-old patient was operated upon for a very severe tuberculous salpingitis. The peritoneal coat of the ovaries was so extensively involved that only a small portion of one of the ovaries could be retained. No nervous or circulatory disturbances followed the operation and the patient regained her health completely.

The 37-year-old patient had a very bad gonorrhœal salpingitis with general

suppurative peritonitis within the pelvis, in which both ovaries were involved, and only a very small portion of one ovary could be saved.

It appears that for menstruation certainly to continue, more than a very small portion of an ovary must be retained and implanted.

Nervousness and Vaso-motor Disturbances.—Of the forty-five cases who reported, twenty-three said "they often felt nervous," but this nervousness seemed to be ordinary occasional nervousness nearly every woman experiences and not, except in one case, the nervous storms which come in young women after removal of tubes and ovaries. One case developed symptoms of hypothyroidism about a year after her operation. None of the women reported "hot flashes" nor any of the manifold neuro-vascular phenomena.

Subsequent Physical Manifestations.—In all the women examined there was found a bulge or slight enlargement of the horn of the uterus, which received the implant, but there was no tenderness and except in four cases, there was no persistent pain.

Four cases were again operated upon on account of pain. Cystic enlargement of the implanted ovary was found in three of these cases.

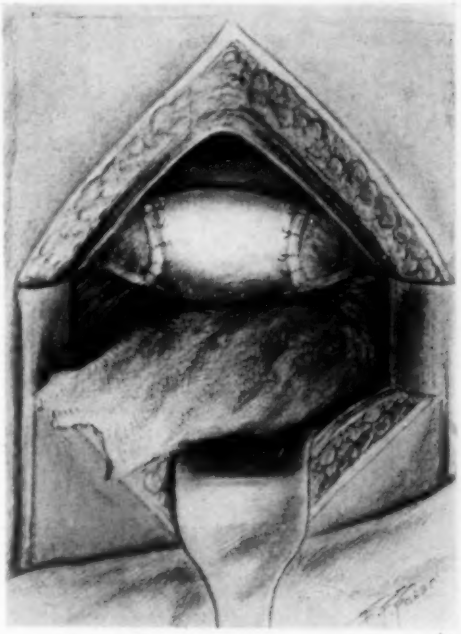


FIG. 7.—This shows the appearance of the uterus and ligaments looking from above through the abdominal wound after the completion of the implantation and reattachment of the ligaments over the implants.

In two of my cases which I followed up for some time, an enlargement of the implanted ovary occurred. I thought it was cystic in both cases, but it entirely disappeared in both cases and gave no trouble.

Comment.—The operation has been used at St. Luke's Hospital since 1905. As this method of implantation of ovarian stroma has resulted in pregnancy in over ten per cent. of the cases, we have been able to follow several years after the operations, and itself does not seriously prolong the usual operative procedures nor add any danger to the necessary operative procedures during and after operation, it seems worthy again to be presented to the notice of surgeons with the hope that it may prove as useful in other clinics as it has at St. Luke's.

BIBLIOGRAPHY

Babcock: Am. J. Obstet. and Gynec., vol. v, p. 423.
Bainbridge: Am. J. Obst. and Gynec., 1923, vol. v, p. 379.
Ibid.: P. 493.
Baldwin: Am. J. Obst., 1902, vol. xxvi, p. 835.

Chalfant: Surg., Gynec. and Obst., 1915, vol. xxi, p. 579.
Knaurer, Emil: Archiv fur Gynakol., vol. lx, 1900.
Estes, W. L.: Penna. Medical Journal, May, 1910, vol. xiii, p. 610.
Estes, W. L.: The Medical Times, May, 1922, vol. i, p. 132.
Estes, W. L., Jr.: Mayo Clinic, Rochester, Minn., June 5, 1923.
Estes, W. L., Jr.: Surg., Gynec. and Obst., March, 1924.
Martin, F. H.: Chicago, Surg., Gynec. and Obst., July, 1908. In this article Doctor Martin has reviewed and included most of the literature of the subject up to date.
Idem: Surg., Gynec. and Obst., 1915, vol. xxi, p. 568.
Idem: Chicago Med. Recorder, vol. xxvi, p. 1.
Ibid.: Surg., Gynec. and Obst., 1922, vol. xxxv, p. 573.
Morris, Robert J.: New York M. J., 1895, vol. lxii, p. 436.
Idem: Med. Record, 1906, vol. lxix, p. 697.
Idem: Am. J. Obst. and Gynec., vol. v, p. 559.
Polak: Pelvic Inflammation in Women. New York, Appleton and Co., 1921, p. 166.
Palmer, Dudley A.: Post-graduate. New York, April, 1900.
Mauclaire: Annual de Gyn. et d'Obsteter, October, 1900.
Storer: Boston M. and S. J., 1915, vol. clxxii, p. 41.
Tracey: Am. J. Obst. and Gynec., vol. v, p. 423.
Tuffier: Surg., Gynec. and Obst., 1915, vol. xx, p. 30.
Idem: Surg., Gynec. and Obst., vol. xxxix, No. 4, 1924.

MANAGEMENT OF BILATERAL OVARIAN DERMOIDS*

By Frank S. Mathews, M.D.
of New York, N. Y.

A dermoid developing in an ovary produces a distortion of it but no other recognizable changes. There is abundant evidence that its internal secretion continues as well as ovulation in such an ovary. Menstruation, corpus luteum formation, pregnancy and delivery at term may occur in the presence of bilateral or multiple dermoids. This suggests the wisdom, when anatomically possible, of removing the dermoid from the ovary rather than the ovary itself, especially when each ovary is affected. As a rule, one distinguishes by the eye the cystic and solid dermoid from the ovary containing it. There is a line of cleavage which is easily followed. Years ago, while doing microscopy, I was much impressed by finding a corpus luteum forming a prominence on the thinnest portion of the wall of a large ovarian dermoid cyst. In spite of the fact that the dermoid spread out the ovarian tissue until it was only 1 or 2 mm. thick, a follicle had ruptured and a corpus luteum developed in normal fashion.

The origin of dermoids is obscure. There is an interesting suspicion that they represent a development of an unfertilized ovum. The following clinical observations have some bearing on the problem of origin.

1. According to Bland-Sutton,[1] dermoids are never found in any other abdominal viscus.

2. They are found chiefly during the period of sexual maturity and very much less frequently in children and the aged (Askanazy).[2] When one is encountered toward the end of life (there are several recorded in women of eighty to ninety-two[6]) there is no means of determining the age at which they originated.

3. Though infrequently seen in children, yet they constitute much the commonest form of ovarian tumors in the premenstrual years. Eight ovarian cysts and tumors have been operated on by my associates and myself at St. Mary's Hospital for Children. Five of them have proven to be dermoids. These patients usually were brought to the hospital because of pain, the result of a twisted pedicle.

4. They are never congenital. This statement is based partly on the authority of Bland-Sutton,[1] who says that he has made a thorough search of the literature and hospital records. The earliest record of ovarian dermoid that I have been able to find is that of the patient of Sant'Anna[3] of Rio Janeiro, operated on by him at the end of the first year of life. Among the cases at St. Mary's Hospital for Children, the youngest was one operated on by me at the age of six years. I have seen several statements in general

* Read before the American Surgical Association, May 4, 1925.

articles [4] dealing with the subject of ovarian dermoids in which it is said that they are rarely congenital but no one of these articles gives a reference to a case report.

5. Ovarian dermoids are found bilateral or multiple too frequently to be explained by chance. A recent report [5] of 100 consecutive patients with ovarian dermoids at the Mayo Clinic showed 128 dermoids in 100 patients. In 13 per cent. of the patients, both ovaries were affected.

The cases forming the basis of this paper are 6 in number. Five were observed by myself and one was the patient of my associate, Dr. Walton Martin, at St. Luke's Hospital. In 4 of these patients, the dermoids were associated with pregnancy.

The first patient on whom a resection was done was a married woman, aged forty-three years, who had never been pregnant. The right ovary was the seat of a large dermoid and the left contained a dermoid 3 cm. in diameter. On enucleating it an ovary was left practically normal in size and appearance. The patient was greatly pleased when told that her ovaries had not been removed. Menstruation continued regularly for five years after the operation and was followed by a normal menopause.

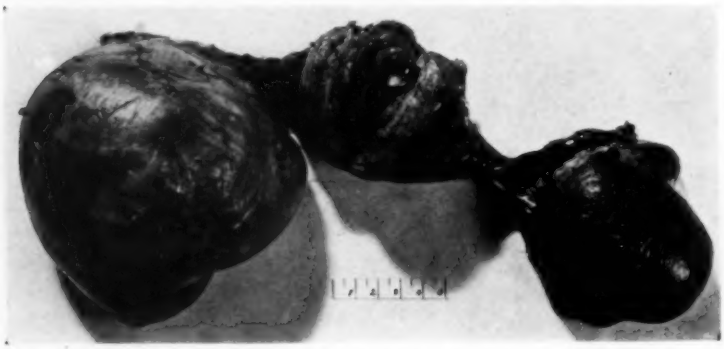


FIG. 1.—Dermoids with early pregnancy.

A second patient was a single woman, aged twenty-nine years and about to be married. A removal of both ovaries in her case would have been little short of a calamity. A dermoid of large size was enucleated from each ovary and a corpus luteum was seen in each.

The third patient came under the care of Doctor Martin at St. Luke's Hospital, November, 1924, at the age of twenty-four years, six months after the birth of her only child. Each ovary contained a dermoid about the size of a lemon. A bilateral enucleation was done and the bed of the tumors closed by suture. Convalescence was normal and menstruation has since been normal in time and amount.

The fourth patient was a married woman, aged thirty-one years, the mother of three children. The uterus was retroverted and adherent and there had been some irregular bleeding. Though pregnancy was suspected, it seemed wiser for many reasons to remove the uterus with the dermoids. (Fig. 1.)

The fifth patient was seen in consultation with Dr. Ralph Lobenstine. At the time of operation, she was at about the middle of her first pregnancy. The ovarian dermoids were giving pain and were of such considerable size as to make operation seem urgent. The cysts on enucleation left the ovary much flattened out but sutures fairly well reëstablished the form of the organ. Though the corpus luteum of the pregnancy was removed with the cysts, the pregnancy continued and ended with the delivery of a normal child at term. Menstruation has continued to the present time with a tendency to be profuse for the first year or two. There has been no subsequent pregnancy.

Patient six is, perhaps, the most interesting of all. She was seen by me with my

associate, Dr. Morris Smith. Her last menstruation had been on August 12, 1922. The operation was performed on October 14, 1922. From the left ovary a dermoid 14 cm. in diameter was enucleated. The right ovary contained two dermoids with diameters of 8 and 3 cm. The corpus luteum of pregnancy was removed with the cysts. The patient who was then twenty-four years of age, continued her pregnancy and was delivered by Dr. K. B. Steele of a normal child at the New York Lying-In Hospital.

In this connection, I might mention another patient with a unilateral dermoid. She is now twenty-nine years of age and in apparent good health. She gave birth to a normal child when twenty-three and has never menstruated since. No symptoms, however, like those of a menopause have arisen. One year ago I removed a dermoid from the right ovary. There was no sign of a corpus luteum in either ovary. Though one might suspect a connection between the dermoid and the suspension of the menstrual function, I am disposed to think that this was a chance association since there was no tumor in the left ovary, since other cases of single or double ovarian dermoid have shown no such effect on menstruation and since infrequent examples of cessation of ovarian function even in young women are recorded following a single pregnancy.

CONCLUSIONS

1. The preservation of an ovary, the seat of a dermoid, has proved a satisfactory procedure. Menstruation has continued and in no case has any condition of the ovary arisen requiring a later operation.

2. Enucleation of dermoids during pregnancy is not inconsistent with the continuance of gestation.

3. On the basis largely of animal experiments, it has been believed that the early removal of a corpus luteum would interrupt a pregnancy. Pregnancy has continued in two of the above patients whose corpora lutea were removed at second and fifth months of the gestation period.

4. Pregnancy has not occurred after bilateral enucleation in any of the patients.

BIBLIOGRAPHY

[1] Bland-Sutton: Tumors Innocent and Malignant, 6th ed.
[2] Askanazy, M.: Die Dermoidcysten des Eierstocks, 1905.
[3] de Sant'Anna, J. (Rio de Janeiro): Kyste Dermoide de l'Ovaire chez un Enfant Agee d'un An. La Gynecologie, 1896, vol. i, p. 213.
[4] Campbell, J.: Bilateral Dermoids of the Ovaries, Clin. Jour., 1917, vol. xlvi, p. 286.
[5] Koncky, J. D.: Ovarian Dermoids, ANNALS OF SURGERY, 1925, vol. lxxxi, p. 821.
[6] Pollack, R.: Proc. Roy. Soc. Med., 1909, II Obstet. and Gynec. Sect., p. 223.

TREATMENT OF UTERINE FIBROIDS*

By John B. Deaver, M.D.

of Philadelphia, Pa.

WITH REMARKS ON PATHOLOGY OF FIBROIDS

By Stanley Philip Reimann, M.D.

DIRECTOR OF THE RESEARCH INSTITUTE OF THE LANKENAU HOSPITAL

The primary consideration with regard to the subject I will discuss is, should all symptom-producing fibroids be removed in the absence of grave constitutional contra-indications, or grave local disease not produced by the fibroid itself? My reply to this question is decidedly in the affirmative. I have never thought a fibroid a simple tumor, nor that, in the absence of local symptoms, it is harmless. Many of these tumors elaborate toxins which cause degenerative changes in the heart, if not in other organs as well. This fact of itself is sufficient reason for removing the tumor.

The second question is, how should the fibroid be treated; by surgery, by radiation, or perhaps by both? This question is still a moot one in the minds of many surgeons. In my own mind there is no doubt but that the removal by operation is the safest procedure.

The non-operative treatment of uterine fibroids, as I view it, is far less efficacious than the operative treatment. I cannot advocate X-ray or radium treatment for these tumors except when there are grave constitutional contra-indications to operation, then of course treatment by X-ray or radium is in order. My objections to these modes of treatment may be briefly stated. From a practical point of view, the length of time necessary to accomplish the cure makes it expensive, and furthermore, except in very experienced hands, the treatment is attended by more risks, more complications and more unfortunate sequelæ than is operation. The risk of destroying the function of the ovaries so important to the well-being of the patient is not by any means trifling. The toxicity caused by either radium or X-ray, particularly by the high voltage machine, must also enter into consideration. It often produces most distressing symptoms which are not always easy to relieve and has been known to incapacitate the patient for an indefinite length of time. The deformity of the skin at the site of the application, either in the shape of discoloration or irritation, is not at all inviting. Furthermore, the pathological tissue which remains behind, and the future of which cannot definitely be forecast may be a matter of serious import. Also in the presence of marked anæmia the blood does not return to normal as promptly as after operation, because bleeding is not so promptly checked. Likewise the blood changes after radiation are not as yet well understood. In a word, this treatment has

* Read before The American Surgical Association, May 4, 1925.

never appealed to me for operable fibroids. On the other hand, consider the low mortality of the operation, which in a recent series of 502 cases was 2.1 per cent. and that the ovaries, if not diseased, can be left, and the woman is minus the tumor and has nothing to dread in the shape of degenerative changes in a questionable residuum. These facts, it seems to me, are good enough arguments in favor of surgery without going into further details.

I wish I could influence the gynæcological surgeon to think as I do with respect to this question. Perhaps he will in the future when the gynæcologist as a specialist will have been superseded by the abdominal surgeon, who will carefully look after all abdominal ills. I wish here emphatically to dispel the illusion that fibroids may and sometimes do decrease in size after the menopause. In my experience I have found the opposite to be the rule.

FIG. 1.—Removal of fibroid. Cutting serosa.

The third question, after operation is once decided upon, is whether to do a total hysterectomy, a subtotal or partial hysterectomy or a myomectomy.

The objections to promiscuous myomectomies are: that consecutive and secondary bleeding after the operation is not uncommon; that infection is more likely than after the usual fibroid operation; and since the fibroid uterus is very often a sterile uterus, there can be less objection to its removal. In the event of either hemorrhage or infection, the subsequent disability is greater than after hysterectomy.

The type of operation depends upon the size of the fibroid, its location and the complications present.

Myomectomy is especially indicated in single isolated fibroids, in pedunculated fibroids, located so they can be readily excised or shelled out with little if any injury to or loss of uterine tissue. The interstitial tumor, as well as the fibroid located within the broad ligaments, can often be removed as an isolated tumor, but one must exercise care in the selection of the case.

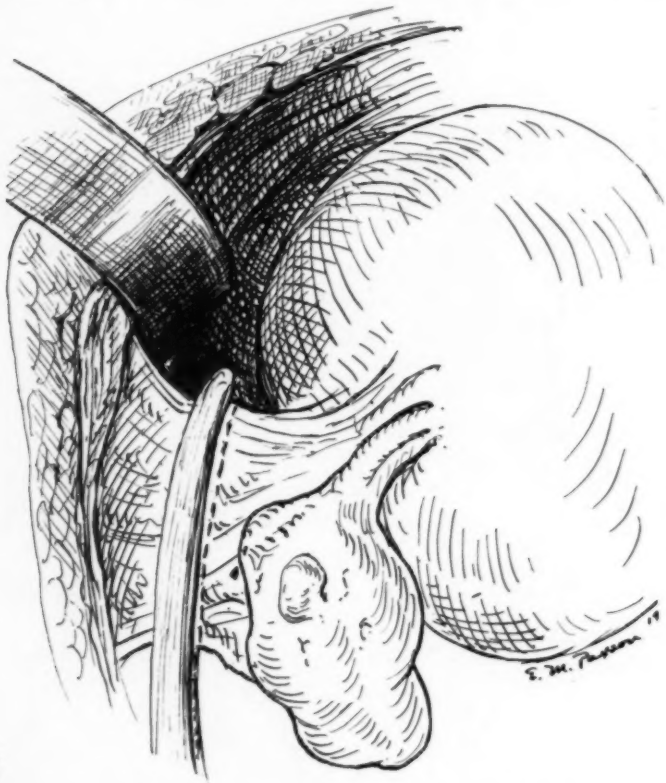


FIG. 2.—Removal of fibroid. Clamp on left broad ligament and round ligament.

Myomectomy is to be especially considered as the operation of choice in the young woman. The general contra-indications to this operation are extreme anæmia, inflammatory disease of the uterine appendages, multiple tumors, also a large interstitial tumor, if for no other reason, because of the difficulty of closing the cavity in the wall of the uterus so as to be perfectly sure that bleeding will not occur.

In submucous fibroid, myomectomy has a limited field. The operation can be only judiciously determined by abdominal hysterotomy. Incidentally I may say I rarely make a vaginal hysterotomy for submucous fibroid, for the following reasons: This route cannot possibly be made aseptic, so that there is greater risk of post-operative infection; one has not the same control of bleeding as in the abdominal operation; and, unless the vagina is abnormally large one cannot manipulate with the same degree of ease and certainty as in the abdominal operation. Myomectomy should leave a normal uterus, plus the presence of ligatures and sutures. While I never promise a patient that

I will do a myomectomy, I always give the assurance that if possible I will do so. Neither the gynæcological nor the abdominal surgeon can definitely settle this question until he sees and palpates the uterus through an open wound. This is the only means of revealing the truth, no matter how much diagnostic skill one may have or may think he has.

In describing the operation of hysterectomy I classify the different portions of the uterus as fundus, body, supra-vaginal and infra-vaginal cervix.

In the simple fibroid where the cervix is normal and the patient has not reached the menopause, subtotal or partial hysterectomy (amputation through the supra-vaginal cervix) is the procedure of choice.

The type of hysterectomy depends upon the age of the patient, the condition of the cervix and of the uterus, the size and site of the tumor, its topography and the complications present in the shape of diseased adnexa, entanglements with neighboring organs, etc.

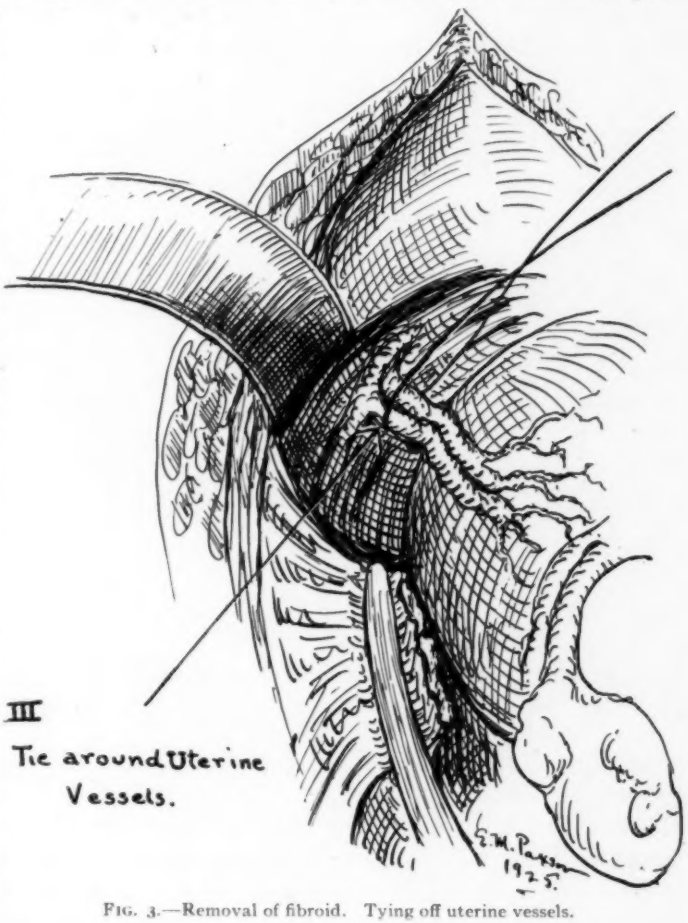


FIG. 3.—Removal of fibroid. Tying off uterine vessels.

In doing a subtotal or partial hysterectomy, the first thing is to deliver the fibroid, pulling it upward and backward, thus making the broad ligaments taut as well as exposing the bladder, then making a transverse incision of the peritoneum just below its reflection from the uterus onto the bladder, when with a small piece of moist gauze the peritoneal reflection with the bladder is carried downward and forward beneath the pubis displacing it, as well as the terminal portion of the ureters, out of harm's way. The left broad, including the round ligament to the pelvic or the uterine side of the ovary,

depending upon whether or not the ovary is to be removed, is then grasped with a Spencer-Wells forceps, the ligament cut and the forceps with point downward is pushed down into the pelvis. This latter manœuvre exposes the uterine vessels which are then clamped with hæmostatic forceps and divided. The same thing is done on the right side, and the supra-vaginal cervix is then amputated, making a V-shaped incision. The cervical canal is next sterilized with the actual cautery, the uterine arteries tied and the stumps of the broad ligament transfixed, tied and sewn into the wedge-shaped cavity of the cervix. The final step of the operation is bringing the reflected serosa over the cervical stump and sewing it to the serosa of the posterior surface of the supra-vaginal cervix.

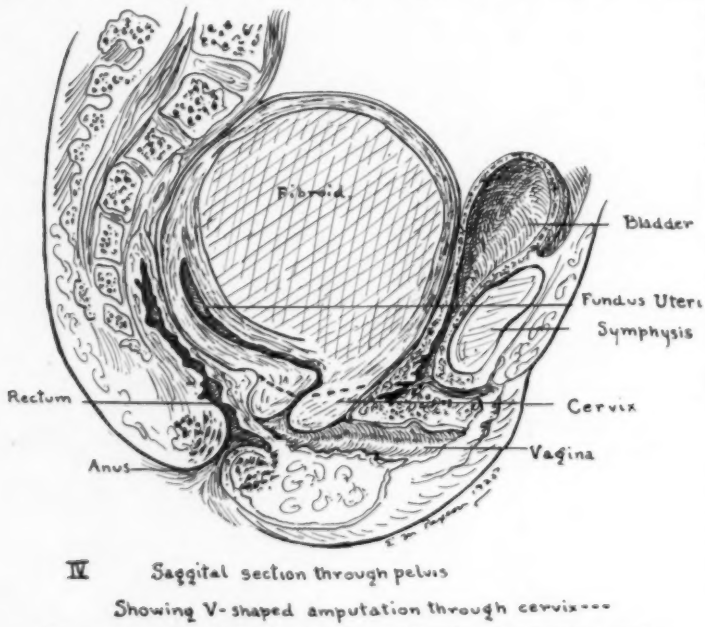


FIG. 4.—Removal of fibroid. Sagittal section through the pelvis showing V-shaped amputation through cervix.

This type of operation I believe to be in all respects the best method of making a subtotal or partial hysterectomy. I admit greater care is perhaps required in controlling the bleeding, than in the operation more commonly practiced, but after the operation is completed the supra-vaginal cervix is suspended and anchored, thus permitting little, if any, chance for future prolapse. In the more popular operation, the supra-vaginal cervix is not firmly anchored, in fact it is suspended in hammock fashion, and with this there is a greater risk of future prolapse. I believe also that in the method I describe, the distribution of the intra-abdominal pressure is better. The location of the fibroid will influence the operator in making his attack, whether anteriorly, posteriorly or laterally. When the fibroid grows laterally, from the supra-vaginal cervix, or from the side of the body of the uterus low down and between the layers of the broad ligament, the incision is made in the anterior layer of the ligament and the tumor enucleated from before backward and below upward. This reduces the chances of injury to the ureter; in fact the ureter should always be exposed and kept in sight. This also is the proper attack when the fibroid is incarcerated in the true pelvis between the layers of the broad ligament.

When the fibroid grows from the fundus of the uterus retroverted and incarcerated in the true pelvis, after dividing and reflecting the peritoneal covering where it passes from the uterus onto the bladder, the supra-vaginal cervix should be cut across, the uterine arteries clamped by grasping the supra-vaginal cervix with the strong Vulsella forceps. Making traction upward, when with the aid of two fingers carried beneath the fibroid the tumor is delivered. The delivery may in some instances be facilitated by bisecting the fibroid and delivering one-half at a time. In the presence of a strongly adherent meso-sigmoid or sigmoid concealing the tubes and ovaries, diseased or not, as the case may be, amputation of the supra-vaginal cervix from before backward is the best method of attack as it presents the least danger of injuring the ureters, the meso-sigmoid or the sigmoid, and is the most satisfactory way of dealing with diseased uterine appendages. I could go more into detail in the technic of the removal of the fibroid tumor, but I take it that the operator's ingenuity plays the most important rôle in the technic. In a series of 336 operations there was 2.3 per cent. mortality.

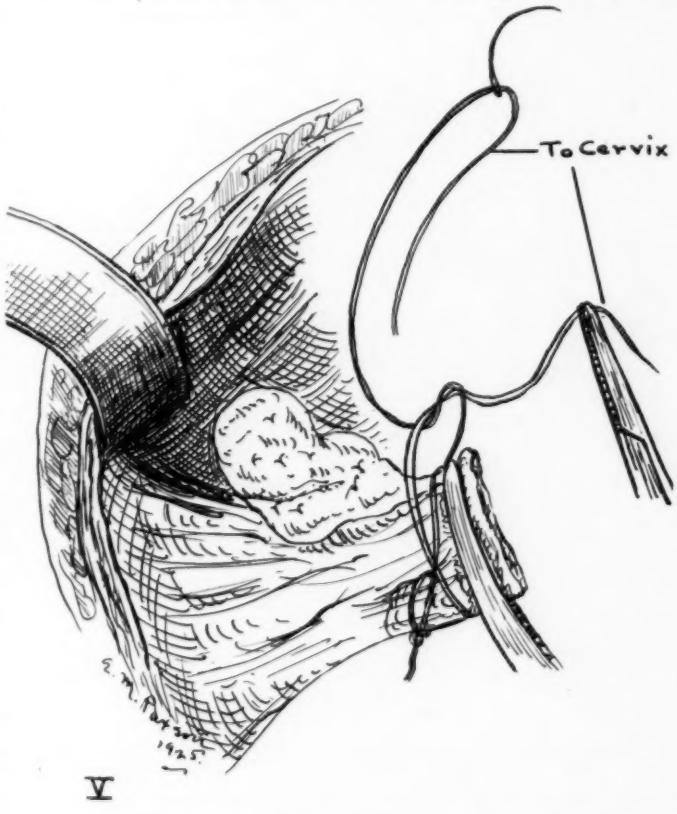


FIG. 5.—Removal of fibroid. Tying off pedicle.

For fibroid tumors developing during or after the menopausal process, particularly when the condition of the cervix is questionable and there is reason to suspect commencing degenerative changes in the uterus, total or complete abdominal hysterectomy is the operation of choice.

The type of total abdominal hysterectomy I prefer is, after separating the bladder, tying off the broad ligaments and the uterine arteries, and exposing the supra-vaginal cervix to free it down to the vagina, the upper portion of

which is also freed far enough down to allow the application of the right-angled clamp which is applied close to the free end of the vaginal cervix, which is pushed well upward before putting on the clamp. The vagina is amputated above the clamp with the cautery knife, thus rendering the vaginal stump sterile. The vagina is then closed with a continuous chromosized catgut suture before removing the clamp and again reinforced after the clamp has been removed. This makes a purely intra-peritoneal operation, no communication having been made with the vagina. The operation is terminated by sewing the stumps of the broad ligaments to the vaginal stump, and sewing the reflected serosa to the posterior surface of the extreme upper end of the vagina. I may say this is perfectly satisfactory and as safe as a subtotal or partial hysterectomy, if the necessary care to control bleeding and avoid injury of the ureter is taken. In the last series of hysterectomies in 166 cases the mortality was 1.8 per cent. One must, of course, be very sure of having controlled all bleeding, particularly of the para-metric connective tissue severed in freeing the supra-vaginal cervix and the vagina. However, one can be master of the situation by making traction on the vaginal stump, grasping it and lifting it up with a pair of Allis' forceps, and at the same time having the broad ligament stump held taut, when bleeding points are easily seen, especially if the sterile Cameron lamp is used. In order to remove any doubt about the ureter in tying the severed uterine artery just after it has crossed the ureter, the ureter can be exposed in the fold of the broad ligament and traced to its entrance into the bladder, which is very easily done. If all oozing has not been arrested, before the reflected vesical serosa is sewn to the serosal covering of the posterior surface of the upper end of the vagina, a hæmatoma will form and later may become infected on

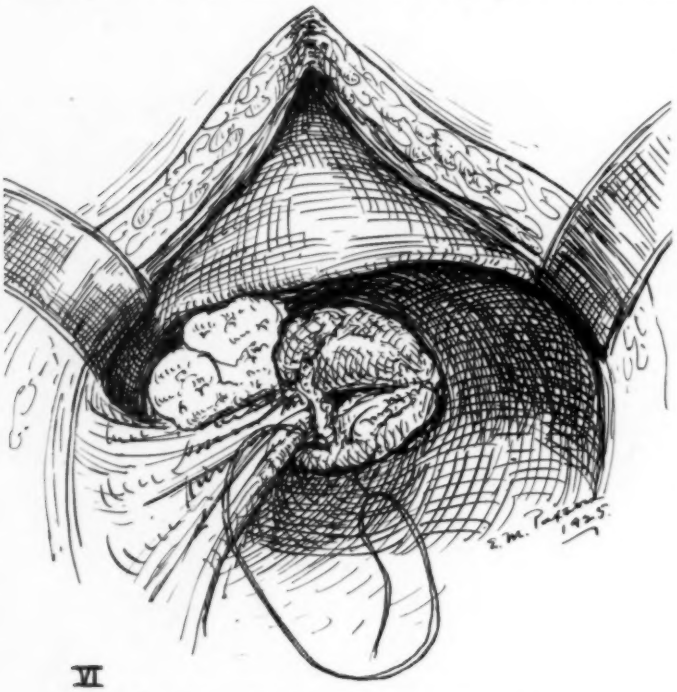


FIG. 6.—Removal of fibroid. Sewing pedicle to cervical stump.

account of the proximity to the large bowel. This may result in abscess and necessitate incision and drainage through the vagina.

The greatest objection to the complete operation is that it foreshortens the vagina. This can be minimized by applying the right-angled clamp as high as possible. Prolapse of the vagina after this operation is very rare.

I have not said anything about vaginal hysterectomy, which I occasionally perform, because it is so seldom indicated in uterine fibroids.

The accompanying illustrations show some of the unusual positions of fibroid tumors, also some of the complications encountered, which necessitates modifications from the usual operative procedure.

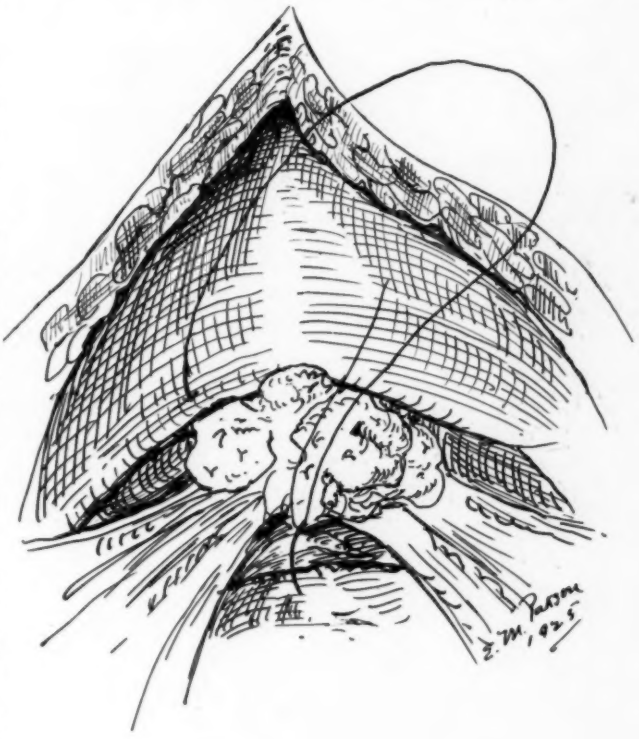


FIG. 7.—Bring anterior bladder mucosa to posterior bladder mucosa.

Remarks on the Pathology of Uterine Fibroids, by STANLEY PHILIP REIMANN, M.D.—The gross pathology of position is of exceptional importance in fibroid tumors of the uterus since much of the symptomatology and treatment depends upon the position of their growth, that is, whether from the fundus, body or cervix of the uterus, whether anterior, posterior or lateral, or in the broad ligaments, and so on. Nevertheless, in this commonest of tumors we are confronted with many questions in what might be called the pure pathology which are still unanswerable. The first and foremost is necessarily the fundamental question of all tumors, what factors determine and control their growth? Since, however, this general question cannot be answered at present, it may be well to discuss a few peculiar to fibroids. We know that they occur chiefly between the ages of thirty and forty years, and practically never before puberty, although Leopold claims that he discov-

ered the nidus for the growth of fibroids in uteri before puberty, a statement which has not been verified nor is agreed to by most other observers. Their point of origin is under dispute. Some fibroids often contain structures other than the usual smooth muscle and connective tissue, it is thought by many that they are definite and very beautiful examples of origin from misplaced germinal tissue. Others, probably with more justification, believe that the point of development of myomas is from the muscle in the very smallest arteries, a conclusion derived from the study of very young myomas in which this relationship could possibly be traced and also helped by the fact that the uterine muscle itself is derived from blood-vessels. Ac-

FIG. 8.—Uterine fibroid (calcareous). Both tubes and ovaries.

cording to others the primary development of myomas is from small swellings detectable in the muscular strands of the uterus. On the other hand, still others believe there is a gradual transition of normal to myomatous tissue and that the isolation as to space is secondary. Perhaps, as Cohnheim has suggested, the germinal centres which develop into the uterine musculature, that is particularly from blood-vessels, are not utilized normally, but Ribbert thinks there are atypical cell groups occasionally encountered in the uterine wall, and that these furnish the starting point of myomas. Some have claimed that they found such minute myoma cell centres, whereas others have found vascular buds which they believe were surrounded by undifferentiated myogenic cells. Still others believe that myomas begin from changes in the uterine musculature itself, the earliest of which is swelling in the interlacing muscle fibres. The fact, as previously mentioned, that myomas practically never occur except during the period of adult sexual life seems to lessen the importance of the germinal centre origin theory. However, since normal growth of the uterus is stimulated at the time of puberty it may be that some germinal centres are stimulated to abnormal growth. Many believe that uteri showing malformations or arrested development are especially subject to myomas, in fact myomas are sequellæ to developmental imperfections.

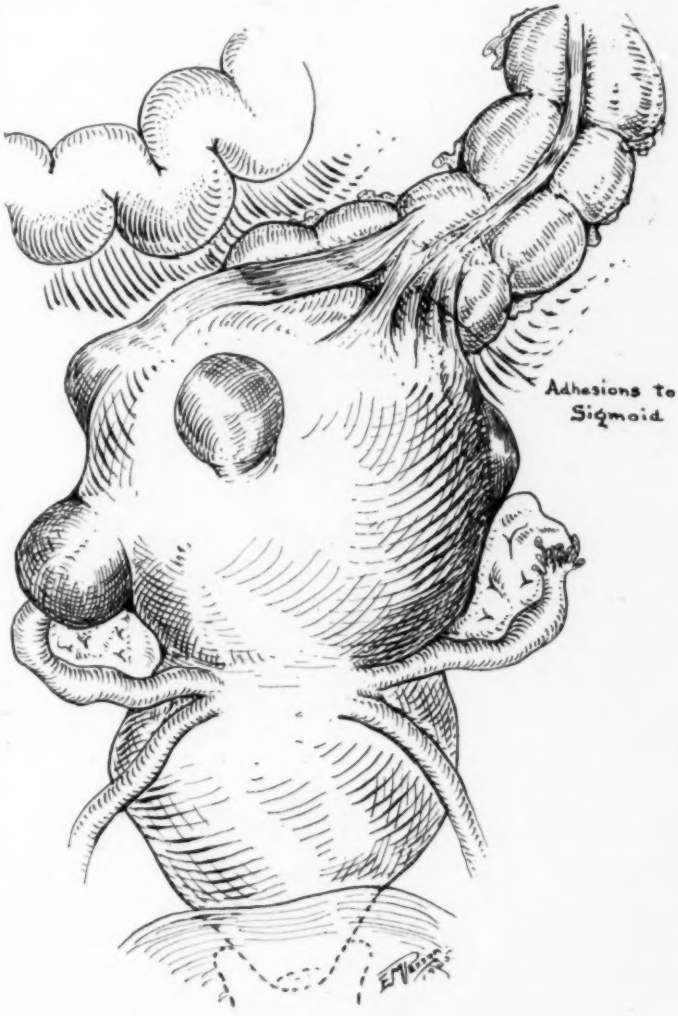


FIG. 9.—Fibroid showing adhesions to sigmoid.

These tumors therefore occupying any position in the uterus, or even in the broad ligaments, are typically composed of fibrous tissue and smooth muscle; as a general rule, the smaller the tumor the more muscle tissue, and the larger, the more connective tissue. The submucous tumors are very apt to be softer than the subserous variety. We have seen uterine inversion, also spontaneous expulsion as the former became more and more distinct from the uterus being attached by a pedicle which finally was detached from the uterus. We have seen torsion of the pedicle cause total necrosis of such a myoma. In some of the myomas which we have encountered coming from between the layers of the broad ligaments, it is quite probable that the pedicle which the myoma possessed at one time, had atrophied and made it appear as though the tumor had developed independently. However, intraligamentary myomas may grow from the muscular portion of the broad ligament adjacent to the uterus. Distortion of the tubes, ovaries and compression of the cervix, displacements and flexures of the uterus, adhesions and so on, are very often determined by position and the numerous and frequent secondary changes to which they are subject.

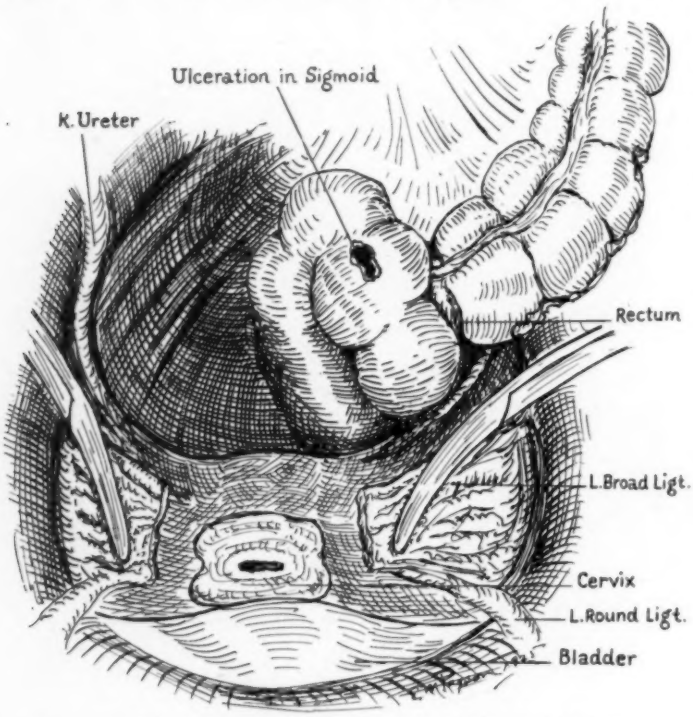


FIG. 10.—Diagram showing ulceration in sigmoid from calcified mass.

Adenomyomas have been encountered in this series of cases rather sparsely, but two in the entire group. There is no particular comment which we can make upon them.

The secondary changes which we have encountered have run the gamut of most of those described, such as passive congestion and œdema, inflammatory œdema, suppuration, necrosis, calcification and the frequent hyalinization. Fatty degeneration and necrosis of muscle fibres were fairly frequent in focal situations. These changes are often said to make myomas decrease in size from disappearance of the muscle elements, the fibrous parts remaining.

The question, however, of the relative amounts of muscular and fibrous tissue may be approached from several angles. The tumor may have originally contained considerable muscular tissue which atrophied and allowed the connective tissue to remain. On the other hand, fatty degeneration and necrosis of the muscle may lead to stimulation of the fibrous tissue into a sort of granulation tissue which will increase the fibrous tissue, and the tumor be composed of both fibrous tissue of neoplastic origin and fibrous tissue of inflammatory origin. A predominance of fibrous tissue is possibly related to a disproportionate development of the vascular supply. The more sensitive muscle tissue cannot maintain its growth, whereas the connective tissue can and does. In such cases, however, the connective tissue is very apt to be hyalinized. It is apparent that this is not a cicatrization process, although curiously enough and illogically enough, attempts have been made to compare it to so-called scirrhous atrophy of the breast! It is, of course, recommended that special stains be used when any of these questions are to be answered in particular tumors. The van Gieson stain in our hands has given fairly good results. This in spite of the theoretical points by which smooth muscle and connective tissue may be differentiated when stained by routine dyes.

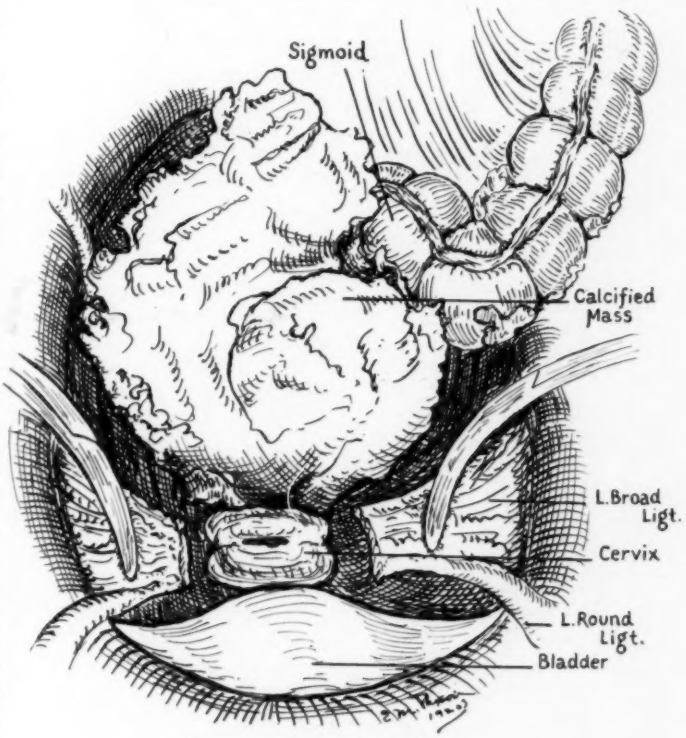


FIG. 11.—Position of calcified mass.

Myomas are said to both enlarge or diminish in size during pregnancy. In the individual case this may be due to poor blood supply, to pulling and displacement of vessels, etc. Necrosis of a myoma during pregnancy occurred in one of our cases. Among the cystic myoma encountered, the changes were due to liquefaction in the centre and the formation of cavernous-like spaces without true linings from fatty degeneration and necrosis of muscle fibres. A lymphangiectatic myoma was encountered, and several that had large

telangiectasis. Hemorrhage causing the formation of cyst-like spaces was fairly common. Calcification was quite common, from small focal areas to complete transformation into a "calculus" as illustrated in Fig. 11.

Among these specimens two of primary sarcoma were encountered, both diagnosed grossly and histologically, and both proved their malignancy by later metastasis. Perhaps we may add a word as to the use of a pathological term. The word "degeneration" is quite often used; "transformation" or "metaplasia" may also be used but not interchangeably, as the following argument will show. As myomas grow, they may not produce typical myoma tissue but sarcoma cells the shape of which differs more and more from that of muscle cells. The nuclei become thicker and shorter, ovoid, polymorphous, sometimes gigantic, frequently hyperchromatic, and show much direct and indirect division. The cells become more crowded with less interstitial substance and are shorter and plump. The presence of larger numbers of giant cells is apparent, and constitutes good evidence of sarcoma. Finally all similarity to muscle cells is lost. This transition to sarcoma is sometimes focal in one place, or in many places, or everywhere in the myoma. Perhaps it first begins in one or several places and then spreads throughout the entire myoma. The sarcoma cells are then the lawless aftergrowth of muscle cells and consequently it is not metaplasia but degeneration. According to most observers, this type of sarcomatous degeneration of the muscular components of a fibromyoma is the most frequent form of sar-

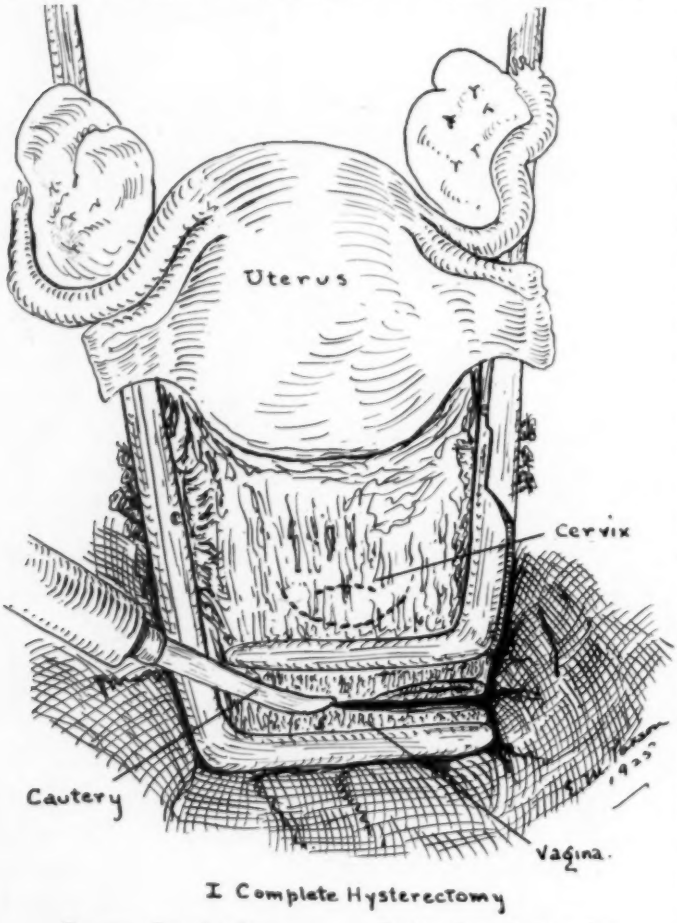


FIG. 12.—Complete hysterectomy. Cutting through the vagina.

coma. Probably the best name for such a tumor is "sarcomatous myoma" which term hints at the sarcomatous degeneration underlying the process. But the fibrous components of a fibromyoma may also give rise to a sarcoma generally of the spindle cell, round cell, or myxosarcoma types. In our cases, metastases unquestionably occurred by the blood channel, for there were nodules in the lungs, in the liver, and in one of the patients a nodule rapidly developed in the thyroid gland. The actual percentage of myomas which become sarcomatous is quite difficult to decide for the same reason that many other questions of percentage are difficult to decide, as for instance, the number of cases of gastric ulcer which become gastric carcinoma. The reason is that we do not know exactly what was there before the tumor was removed, nor can we tell what would have happened if the tumor had been allowed to remain and the surgeon had not removed it with his knife.

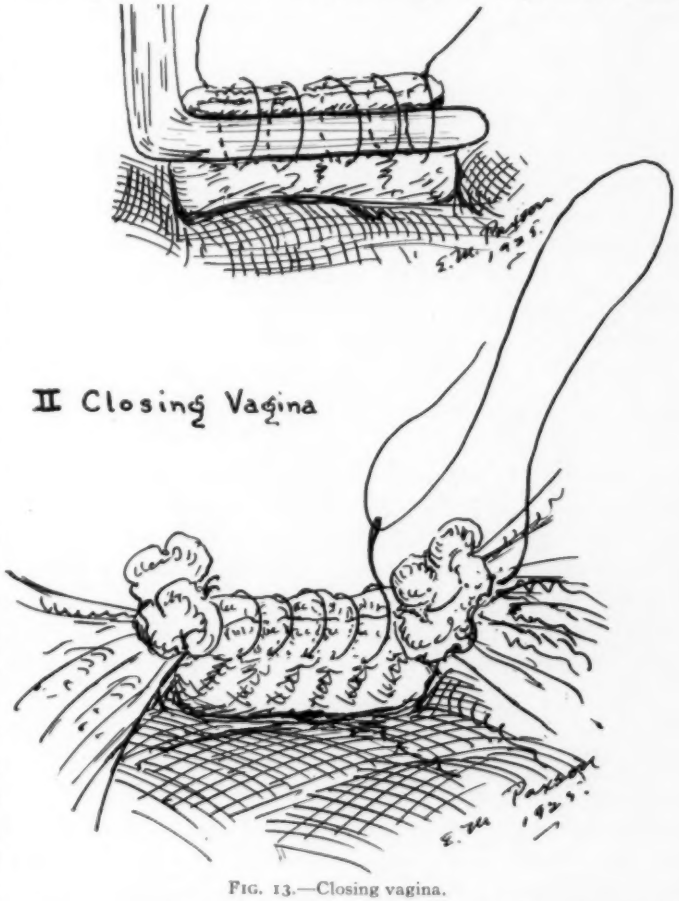


FIG. 13.—Closing vagina.

Careful studies from many regions of fibroids have shown that a considerable number yield isolated histological fields which are difficult to distinguish from sarcoma, that is, a single histological section will give all the appearance of sarcoma when the gross appearance is decidedly against it. This is not rare, but in our opinion the differential diagnosis in any one given slide between myoma and sarcoma is so difficult with few exceptions, that the histological examination is only a part of the diagnostic data. Statements that from 1½ to 2 per cent. of myomas are in reality sarcomas are quite common in the literature, but percentages such as 10 per cent. (Warnekioss) are much too high and are probably based on insufficient data as suggested above.

We have examined two specimens which had been treated by X-ray and radium sometime previous.

The changes which we found could in no way be interpreted as characteristic of this form of therapy. The results of X-ray and radium therapy in malignant tumors, especially carcinoma, have been adequately described and seem to be, at least at certain stages after treatment, fairly characteristic. We have found this especially true in tumors of the breast of which we have received quite a few at varying intervals after X-ray treatment. The changes were sufficient to make one say that the breast had probably been X-rayed before surgical removal. In these fibroids, practically all that could be found was that the muscular tissue was conspicuous by its absence, and the connective tissue in such sections as we took from various parts of the tumors, showed considerable hyalinization. The endometrium was atrophic in part, but was shaggy toward the fundus. We can by no means say that the hyalinization as observed in the connective tissue was due to X-ray or radium therapy, for hyalinization is so common in any of the myomas that it is nothing characteristic.

On the other hand, from the point of view of X-ray and radium therapy, disease of the tubes and ovaries was found in fully half of the cases (255 in 525) in degree varying from simple hydrops of the tubes to severe acute diffuse suppurative inflammation; from mere fibrosis of the ovaries which was normal for the age of the individual, to larger or smaller cysts of various varieties, and acute and chronic inflammatory conditions of various degrees. The difficulties of clinical diagnosis in these cases appeal to the pathologist and in view of the uncertainties so often attending X-ray and radium results, it would seem wise to take this matter of extra-uterine disease into very careful consideration as illustrated by a patient who was admitted to the hospital after radium therapy for bleeding. A huge pelvic collection of pus was evacuated through the vagina and a fecal fistula was soon established. Death from infection took place some two weeks later, and at autopsy most of the uterus, the left tube and ovary, and a large portion of the sigmoid had disappeared into a soupy grumous mass. Nor is this an isolated experience in our own autopsy work, and reiteration of this danger should be sufficient as warning without further illustrative cases nor quotations from other pathologists.

On the other hand, death following operation for fibroid of the uterus is such an uncommon occurrence, and when it does happen, can usually be correlated to an unforeseen accident such as pulmonary embolism. This appeals to the pathologist who knows that when the specimen is removed with few exceptions of sarcoma, he has the entire pathological process in his own hands. Finally in the study of the patient's return to our follow-up department the practically universal report has been, "all is well."

TREATMENT OF UTERINE PROLAPSE AND RECTOCELE BY CLOSURE OF THE POUCH OF DOUGLAS*

(JONES-MOSCHCOWITZ)

By John Homans, M.D.

of Boston, Mass.

The operation to be described is based upon the procedure advocated in 1912 by Dr. Alexis V. Moschcowitz [1] for the cure of rectal prolapse. Doctor Moschcowitz demonstrated that true prolapse of the rectum was associated with a remarkably deep pouch of Douglas, which permitted intra-abdominal pressure to force the anterior rectal wall downward through the anal canal. Having shown that the condition was in fact a hernia, he advocated and successfully practiced an intra-abdominal closure of Douglas' pouch as the most effective means of obliterating the neck of the hernial sac. Some years later, in 1916, Dr. Daniel Fiske Jones [2] published a paper in which he reiterated the value of this procedure and showed how logically the principle employed could equally well be adapted to the treatment of uterine prolapse and rectocele. Neither surgeon made claims for an originality for which both undoubtdly deserve credit.

Fig. 1.—Diagram representing a normal pelvis. Note relations of the pouch of Douglas. The pelvic fascia between rectum and uterus marking the low point of the pouch is represented as a raphé.

Many operations for prolapse take into consideration the point of view which regards downward displacement of the uterus as a true herniation, but none, so far as I know, employ closure of the deep cul-de-sac as a major or even integral part of the procedure. Dr. John G. Clark [3] speaks of the value of closing Douglas' pouch in the vaginal operation for rectocele and, on

* Read before the American Surgical Association, May 4, 1925.

rare occasions, in the course of the abdominal part of an operation for prolapse. He gives credit to Doctor Moschcowitz and Dr. L. Frank[4] for emphasizing the importance of such a step. I find an allusion to this principle in Graves' Text Book of Gynæcology.[5] I know, however, of no published study of the Moschcowitz closure of Douglas' pouch as advocated by Doctor Jones for the cure of rectocele and prolapse of the uterus. For this reason I feel justified in offering the following account of the operation as I have practiced it and of its results under the various circumstances for which I have used it.

FIG. 2.—Diagram representing an abnormally deep pouch of Douglas. The condition suggested might be congenital or acquired.

To review the pathologic anatomy upon which the operation is based the following diagrams may perhaps serve. In Fig. 1 the normal pelvic relations are shown; the pelvic fascia closing the cul-de-sac in a blunt point between the rectum and uterus and at a level a little below that of the cervix.

Figure 2 shows a deep pouch, due, primarily perhaps, to a congenital defect or lack of strength in the pelvic fascia. It is easy to see how this condition may lead in either sex to rectal prolapse and in females to rectocele.

Figure 3 suggests the formation of a rectocele, the anterior rectal wall pressing across the deep cul-de-sac into the posterior vaginal wall, and Fig. 4 pictures the herniation of abdominal viscera other than the rectum through the posterior wall of the vagina by way of the same deep pouch. It is almost unnecessary to point out how readily these conditions may be distinguished upon rectal examination and how a true rectocele interferes with the act of defecation.

Figure 5 illustrates a degree of prolapse of the posterior vaginal wall sufficient to draw down the uterus. A further descent of the uterus would result in procidentia.

In respect to the cure of such conditions, it goes without saying that the closure of the deep pouch is part of a combined procedure of which the first step is an extensive repair of the anterior and posterior vaginal walls.

Whether or not the entire operation, vaginal and abdominal, is accomplished at one sitting depends upon the excellence of the patient as an operative risk. Not rarely two sittings are advisable, especially in the aged, for after a long and perhaps bloody vaginal repair the abdominal operation may entail a considerable risk.

In the performance of the closure of the cul-de-sac a rather extreme Trendelenburg position is helpful. Should examination with the pelvis exposed then demonstrate the presence of a very deep pouch of Douglas, that is, a pouch extending down between rectum and vagina for two, three or even four inches beyond the cervix, a pouch which very likely has already been closed in some degree by the repair of the posterior vaginal wall, the cul-de-sac may be obliterated in any convenient way. I have used spiral stitches of large chromicized catgut, one for each side of the pelvis and not the series of circular silk stitches advocated by Doctor Moschcowitz, for the reason that the two stitches flatten the pouch from back to front and draw the cervix toward the sacrum with less danger, I believe, of having the stitches pull out of the peritoneum and feeble fascia behind it than would be the case with circular stitches; nor do I see the need of a non-absorbable suture material.

FIG. 3.—Diagram representing a true rectocele. The anterior rectal wall pushes into vagina, thrusting the posterior vaginal wall forward and downward. The uterus is retroverted and in a state of moderate prolapse. Rectal examination discloses the nature of this change.

Figure 6 illustrates the starting of one of these stitches; the fundus of the uterus being drawn forward and the sigmoid pushed well up into the abdomen. Each stitch starts at the bottom of the pouch and is carried up in a spiral manner picking up the vaginal wall, lateral pelvic wall and lateral surface of the rectum in a series of turns up to a level perhaps an inch above the lowest point of the cervix. Figure 7 shows both stitches in place but not yet drawn tight. When both are completed the cervix is drawn firmly toward the promontory of the sacrum and the pouch of Douglas is obliterated except

for a narrow slit between rectum and cervix. This may be closed at the top by additional stitches if it seems to offer a point of entry for the small intestine.

As to the disposal of the uterine fundus, any one of several methods may reasonably be employed—a Gilliam suspension, an Ohlshausen fixation of the round ligaments or a firmer fixation of the fundus itself with catgut or silk, the desideratum being to pitch the fundus forward so that the uterus shall lie as a shelf across the brim of the pelvis.

It will be noted by examining Fig. 8 that in the standing position, intra-abdominal pressure is little exerted against the cervix but is, for the most part, transmitted by the body and fundus of the uterus toward the anterior abdominal wall. Thus the operation not only closes the neck of the hernial sac leaving the uterus almost like a shelf across the superior strait of the pelvis † but tends to prevent the swinging back of the cervix into the axis of the vagina. The operation is not an easy one and requires patience and care.

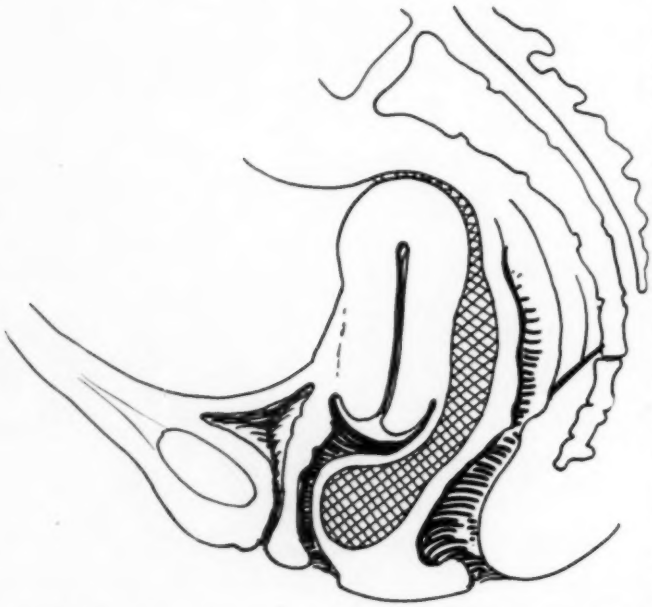


FIG. 4.—Diagram representing a protrusion of the posterior vaginal wall, that is, a herniation of the pelvic contents through the posterior vaginal wall by way of a deep pouch of Douglas. Rectal examination will show that this is not a true rectocele.

The Selection of Patients for Operation.—No particular plan has been used in choosing subjects for this operation. In carrying out the abdominal part of a combined operation for prolapse or procidentia, Douglas' fossa was closed whenever it appeared to be particularly deep, or roughly, when it extended for more than two inches below the cervix. On this basis, as I now discover, more of the patients operated upon suffered from a pronounced relaxation of the anterior vaginal wall than of the posterior. In these individuals the deep cul-de-sac can hardly be held to have been the starting point of the associated descent of the uterus. I believe, however, that the inclusion of these cases in the series, though a departure

† The interposition of the uterus at the upper end of the pelvic outlet, though not a primary object of the operation, has an advantage over the "Interposition" operation of Watkins in which the uterus is brought forward in front of the bladder, for that operation still leaves the way open for the development of rectocele, that is, by a push from behind and below the cervix, while with closure of the pouch, a recurrence of rectocele is unlikely.

from the indications laid down by Doctor Jones, adds to the value of this report. All patients in the series suffered from such a degree of prolapse that the cervix appeared at or outside the vulva on standing.

Results.—The operation has been performed upon thirty-two patients, varying in age from twenty-one to seventy-one. The earliest operation was performed in 1916; the most recent in 1923. In all instances, more than two years have elapsed between the operation and the date of the final report. There were no operative deaths in the series.

Of the thirty-two patients treated, thirty have been traced. In a large majority of these instances the patients have actually been examined. In a few, the patient's own statement ‡ has been accepted as a basis for the result reported. Patients are considered to have been cured in whom the anatomic result is satisfactory or who, without examination, report themselves as being in good health and without complaints. Patients are considered to have been improved who present an anatomic recurrence with a functional cure or who have been partly relieved both anatomically and functionally. These definitions govern the report of results detailed below.

FIG. 5.—Diagram representing a considerable descent of the uterus in association with a deep pouch of Douglas.

Of the thirty cases traced, twenty-two were cured, or 73.3 per cent; four were improved, making a total of twenty-six cured and improved cases, or 86.7 per cent. There were four total failures, or 13.3 per cent.

The failures are somewhat instructive and give more than a hint of the circumstances under which the operation is likely to fail. The first resulted from my poor judgment in performing the operation in the presence of a

‡ It is clear that, as regards the anatomic result, a physical examination is alone satisfactory. As an instance of an anatomic failure which would have been missed without a physical examination, one woman reported herself as having been entirely relieved, yet the cervix descended to the vulva on straining.

chronic tube-ovarian abscess; the second patient had previously been operated upon at other hands with immediate recurrence; the third, a very neurotic woman who had previously been subjected to some other pelvic operation, reported herself a failure and was again operated upon by another surgeon (hysterectomy) without relief, and the fourth was mistakenly allowed to go without a repair of the posterior vaginal wall. In none of the four was rectocele a predominating factor. Two were instances of symmetrical procidentia and two of prolapse with a predominating cystocele.

Of the four improved cases, two were young women who have since borne children. In both, the operation had been completed by a Gilliam suspension. Both have been considerably relieved and are reasonably satisfied with their condition, and one of them, who suffered from procidentia before operation, has no sign of uterine protrusion at present. A third patient "felt something give way" over a year after operation and now the cervix comes to the vulva on straining, yet she considers herself well.

FIG. 6.—Diagram to show the starting of one of the latera spiral stitches. The lines of crosses indicate the extent of the proposed closure of the pouch of Douglas.

The cured patients, 73.3 per cent. of the list, comprise seven instances of procidentia among which were three patients suffering from an excessive relaxation of the anterior vaginal wall, one from a predominance of rectocele and three from a symmetrical protrusion of the uterus. Of the fifteen cases of prolapse, six showed a dominant cystocele, four a symmetrical protrusion and five a dominant relaxation of the posterior vaginal wall. The patients were of all physical types, several being aged, flabby women whose abdominal walls were greatly relaxed. I am inclined to believe that the operation has had among these patients a fair test which demonstrates its usefulness in a variety of pathologic conditions of which the basic lesion is herniation of the uterus through the pelvic outlet. In fact the operation in many instances has

closed the neck of the hernial sac and, supported by a thorough vaginal repair, has aided materially in the cure.

Without quoting individual cases, I feel justified in suggesting some of the conditions for which the operation appears, by a study of the results, to be excellently suited and others to which it is less well suited.

First and foremost it is suitable to instances of prolapse or procidentia in which rectocele is a predominating factor. In this short series there are, among such patients, no failures. Two patients, indeed, whose cul-de-sacs were astonishingly deep, suffered at one time from rectal prolapse and at another from rectocele. Each was cured of both conditions. Second in significance is the success of the operation among women who have a large uterus. The factor of size seems to favor the interposition of the uterus as a bar or shelf across the pelvis, shunting the intestines against the pubis and the lower abdominal wall. The helpfulness of a good-sized uterus favors the use of the operation in young women who may indeed be left unsterilized and subsequently bear children without total recurrence. Conversely, an atrophied uterus would appear to be an unfavorable factor, yet one patient in the series was subjected to closure of the pouch for a vaginal prolapse which had followed a total hysterectomy and the result has been good.

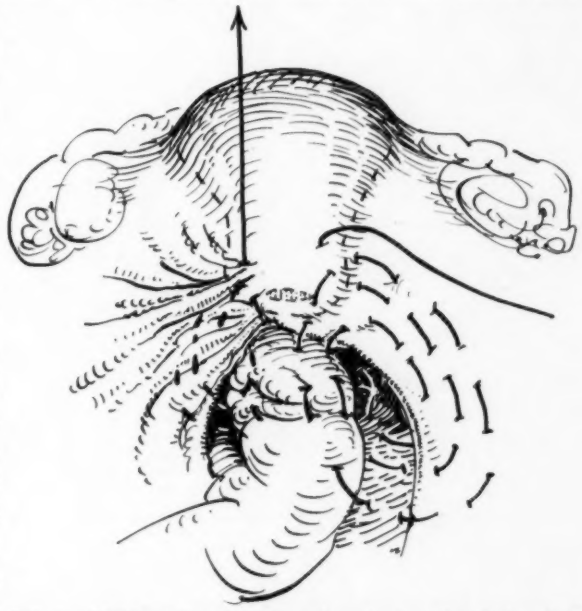


FIG. 7.—Sketch of the pelvis from above to show the placing of the two spiral stitches and the nature of the closure they produce.

The third significant factor in the operation is the very small part which the character of the abdominal wall plays in its success. The attachment of the fundus or of the round ligaments to the recti is used rather to tilt the fundus forward than to fix it permanently. In fact the operation has succeeded admirably in a number of women with badly relaxed and protruding abdominal walls.

The operation is difficult to perform without the aid of a rather exaggerated Trendelenburg position and very thorough walling off of the intestine. For this reason it offers a severe ordeal for women with feeble hearts and excessive adiposity. Moreover the presence of an excessive amount of fat about the sigmoid flexure and behind the peritoneum makes closure of the deep

pouch a difficult feat. A feeble heart and excessive fatness are therefore contra-indications.

To sum up, closure of the pouch may be a difficult but not of itself a dangerous procedure. It not only closes with some effectiveness the neck of the hernial sac but leaves the uterus interposed across the superior strait of the pelvis, the fundus anterior and the cervix posterior, in such a position that pressure from above is transmitted forward toward the pubis and no longer tends to push the cervix down into the axis of the vagina.

FIG. 8.—Diagram to show the closed pouch and the position of the uterus at the conclusion of the operation.

And though the procedure, as here reported, has been used without the aid of very carefully determined indications, it may apparently be relied upon, in association with a thorough vaginal repair, to cure a rather high percentage of prolapse and procidentia, and is useful especially when the posterior rather than the anterior vaginal wall is chiefly relaxed; when the uterus is of fair or good size and when the abdominal wall is so relaxed as to offer a poor support for any form of fixation.

BIBLIOGRAPHY

[1] Moschcowitz, A. V.: Surg., Gyn. and Obst., 1912, vol. xv, p. 7.
[2] Jones, D. F.: Boston Med. and Surg. Jour., 1916, vol. clxxv, p. 623.
[3] Clark, J. G.: Surg. Clinics of North America, 1921, vol. I, p. 77.
[4] Frank, L.: Am. Jour. of Obst., 1917, vol. lxxv, p. 706.
[5] Graves, W. P.: Text Book of Gynæcology, 1918, p. 699.

A HANGER METHOD FOR THE REPAIR OF PROCIDENTIA UTERI*

By George W. Crile, M.D.
of Cleveland, Ohio

It is easy to operate for procidentia. It is difficult to cure procidentia. To operate is easy because the tissues are elastic and abundant. To cure is difficult because the tissues are elastic and abundant. Because of their elasticity, neither the perineum nor the utero-sacral, the anterior nor the broad ligaments can provide a permanent anchorage. Every surgeon is familiar with the patients who, after a suspension operation for the cure of procidentia, return with the same symptoms, the same distress and a second partial, if not complete prolapsus of the uterus.

The necessity of providing some permanent anchorage was impressed upon me twenty-one years ago by a patient with complete procidentia for which she had already been operated upon elsewhere twice with but temporary relief, the first operation having been performed fifteen years before, the second operation but six months before. The patient was a Bohemian woman whose livelihood demanded the performance of heavy manual labor. In despair of providing any permanent relief by the operative method which had already been twice tried without avail, I decided to utilize the one available permanent anchorage, namely the anterior abdominal wall and by practically the same technic as that which I shall describe, I suspended the entire floor of the pelvis—the bladder, the rectum and a portion of the uterus—on the abdominal wall. The result justified the adventure and the woman returned to her heavy manual labor without further misadventure.

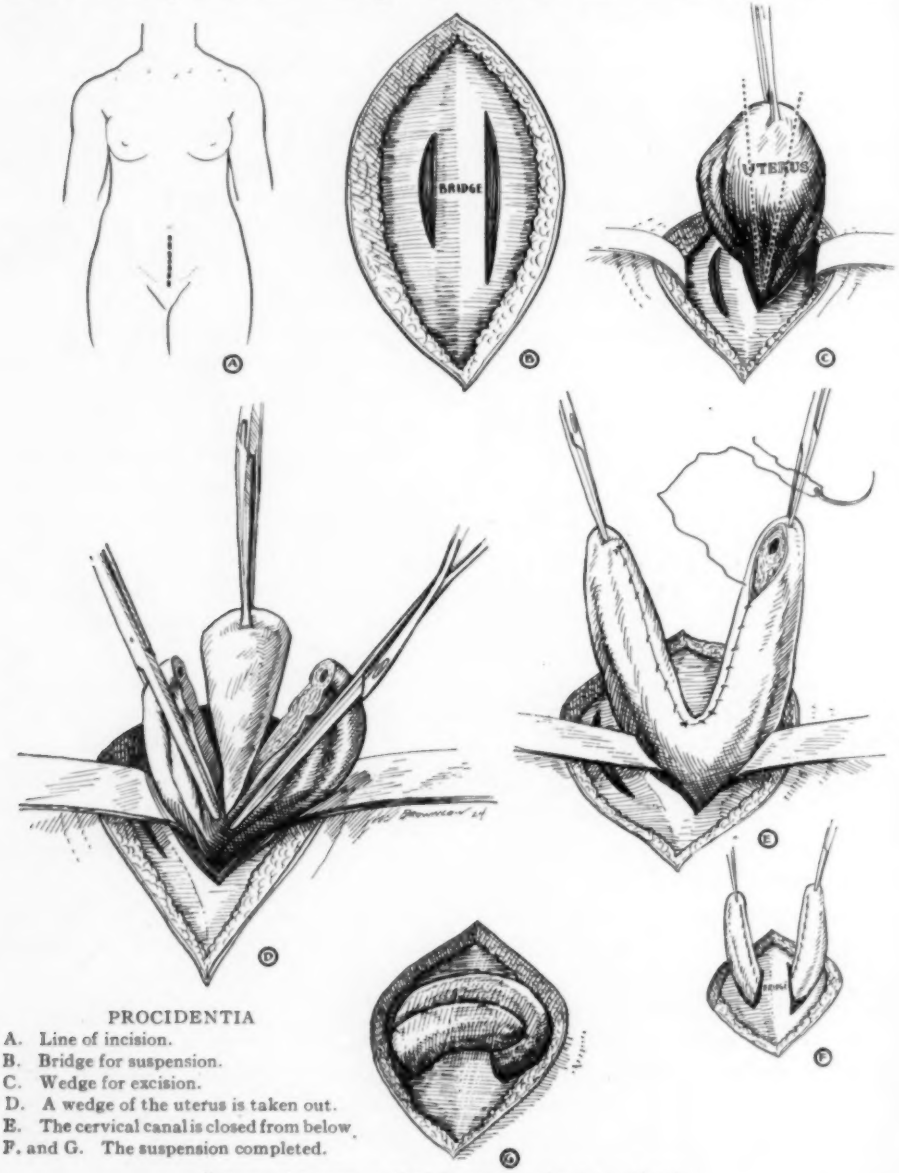
At about the same time another case with a somewhat similar history gave another opportunity to try the same manœuvre, again with success. Since that time this manœuvre has been employed in a number of cases of procidentia. As it necessitates a partial hysterectomy, it is obviously not adapted to prolapsus within the child-bearing period.

The technic may be briefly described as follows: A low abdominal incision is made to the right of the median line. A wedge-shaped section of the central part of the uterus, the apex extending down to the cervix, is removed, leaving a lateral strip of uterus free of mucosa on each side, together with the attachments of the round, the broad, the anterior and the utero-sacral ligaments. Bleeding is controlled and the raw surface of each side and across the cervix is covered by suturing. The entire group of organs—the bladder, the rectum, the cervix and the vagina—involved in the descensus may be raised or lowered by these two handles and it remains only to find the anchorage whereby the group may remain permanently elevated by these handles.

To this end a short incision is made through the external fasciæ, muscle and peritoneum, parallel to the original incision but just to the left of the

* Read before the American Surgical Association, May 4, 1925.

median line as in a Gilliam operation, this opening, however, being made just large enough to draw through it the left "handle" of the descensus complex; the right handle is brought up through the primary incision. Thus the two "strap handles" emerge well up and out of the right and left



PROCIDENTIA

A. Line of incision.
B. Bridge for suspension.
C. Wedge for excision.
D. A wedge of the uterus is taken out.
E. The cervical canal is closed from below.
F. and G. The suspension completed.

FIG. 1.—A hanger method for the repair of procidentia.

incisions with a substantial and dependable strip of abdominal wall lying between them. The two handles are crossed over this strip as if to grasp it and are sutured there, thus forming a permanent immovable opponent to further descensus.

It is obvious that the condition which makes this operation possible is the one sure indication for its performance. Unstretched ligaments can not reach the abdominal wall but unstretched ligaments in turn are still capable of performing their essential suspending functions. It is the stretched tissues in which the elasticity has been exhausted by constant strain that on the one hand indicate the need for the operation, and on the other, permit the manœuvre to be accomplished.

As to the relief of the condition, it is obvious that there can be no recurrence of procidentia as such. In extreme cases, however, there has been a partial cystocele and rectocele. For a short time after the operation the patient will inevitably feel a tugging upon the abdominal wall. This discomfort, however, is of limited duration and it deserves but slight consideration in contrast to the diminished probability of a return of the prolapsus. It should be borne in mind also in estimating the value of the procedure that procidentia is most prone to occur after the child-bearing period in multiparous women in whom the entire generative apparatus is already stretched and weakened beyond the possibility of permanent restoration by other manœuvres.

CORRESPONDENCE

LATE RESULT OF NEEDLING AN AORTIC ANEURISM

EDITOR ANNALS OF SURGERY:

Sir:

In the ANNALS OF SURGERY for November, 1912, under the title of "The Surgical Treatment of Aortic Aneurism," I reported a case in which, in spite of prolonged medical treatment, the symptoms became so severe that the patient and her doctor thought she was dying.

After a series of needlings by the method devised by Sir Wm. Macewen, patient improved so markedly that, as she expressed it, she was given a new lease of life. She was able to go to the Coast for a holiday in 1910, after three needlings, and after further treatment at the end of 1910, she was able to resume her ordinary household duties.

Recently, owing to her having strained herself by repeated lifting of a very heavy preserving pan, while making marmalade, there was a modified recurrence of symptoms, and she came to see me at the Royal Infirmary, Glasgow.

A needle introduced on this occasion encountered a much thickened *anterior* wall of the aneurism, thus showing that the effect of the needling is not confined to the area on the posterior wall, scratched by the needle, but extends gradually round the circumference.

The case was shown by me to the Members of the Inter-State Post-Graduate Clinic Tour of American Physicians who visited my Clinic at the Royal in June of this year.

Thus this woman who was very seriously ill and appeared to be dying in 1909, has been able, after treatment by needling, to carry out her ordinary work and enjoy life for a subsequent period of 15 years, which I think, justifies my again drawing the attention of the Profession to a very valuable method of treating all aneurisms, but particularly those where other methods are not available, as in the aortic variety.

JOHN A. C. MACEWEN, M.D.,

Glasgow.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS of SURGERY
227-231 So. 6th Street
Philadelphia, Penna.